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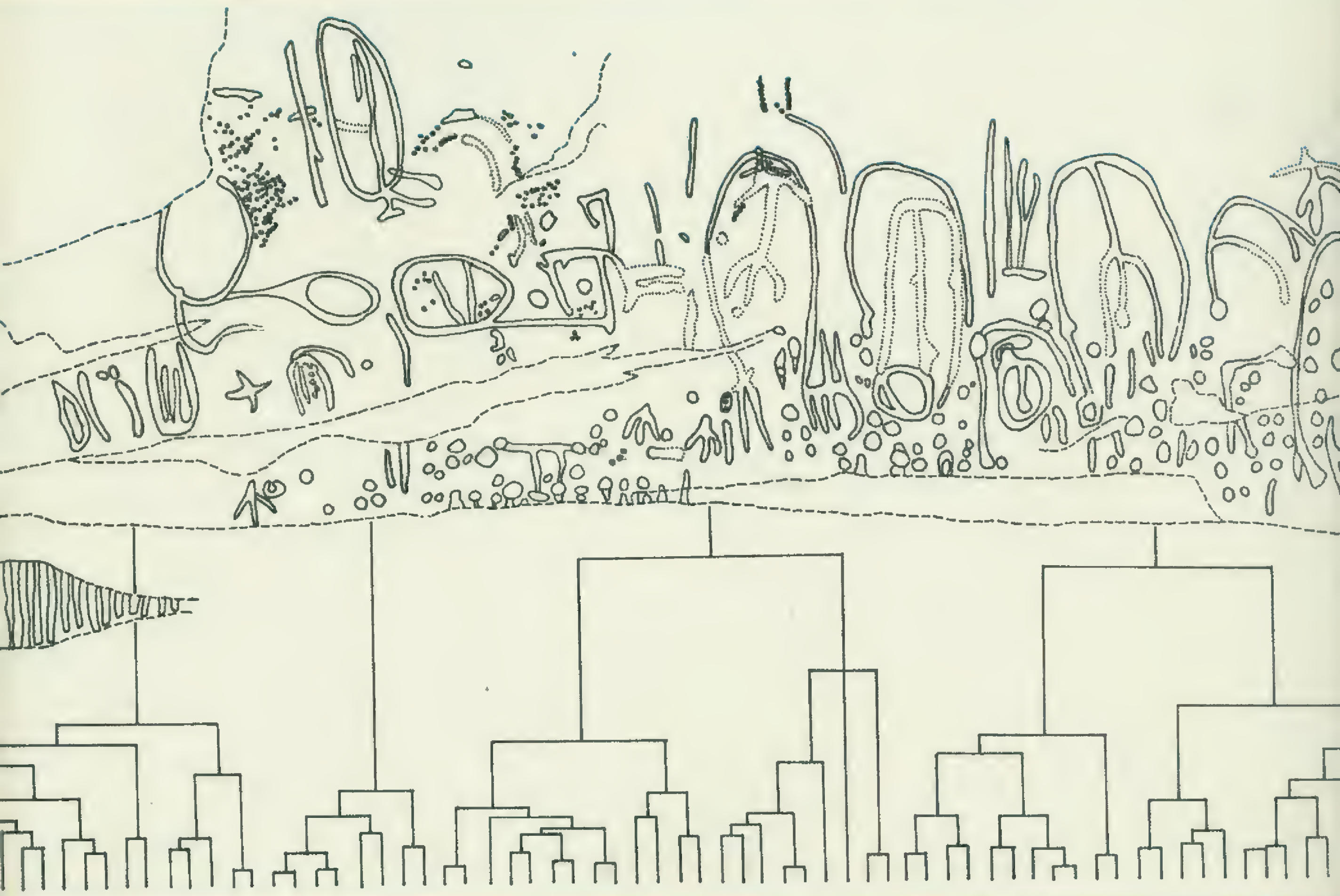

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DICKINSONIA: POLYCHAETE WORMS FROM THE LATE PRECAMBRIAN EDIACARA FAUNA, SOUTH AUSTRALIA

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ABSTRACT

Dickinsonia is an extinct genus of errant polychaetes which dominated the South Australian late Precambrian Ediacara fauna. Like Recent *Spinther* they were characterized by the anterior body segment being fused around and in front of the prostomium. Neuropodia were reduced and phylogenetically lost in *Dickinsonia*, probably as the worms outgrew the range of width at which these appendages could function efficiently for locomotion. Freed from reliance on neuropodia, the widest worms ever known were produced, and segment length shortened. New material allows the removal of some of the specimens initially assigned to *D. tenuis* Glaessner and Wade to the new species *D. lissa* and *D. brachina*.

The genus *Dickinsonia* is the most common taxon in the Ediacara fauna in the Adelaide Geosyncline (Glaessner, 1961; Wade, 1968, table 1). The fauna occurs in a short stratigraphic interval not far above the base of the upper member of the Pound Quartzite (Wade, 1970) which Forbes (1971) has named the Rawnsley Sandstone Member. The areas where *Dickinsonia* has been collected are marked 1–7 on Fig. 1, which shows the distribution of the Pound Quartzite in the central Flinders Ranges where it occurs widely beneath a major unconformity capped by basal Lower Cambrian rocks of the Parachilna Formation (Dalgarno, 1964; Wade, 1970). Mr J. C. Gehling (pers. com.) has since found the fauna to the east of the area studied by Wade, at Reaphook Hill (7), and Dr B. Daily has traced it further to the east in the Mt Scott Range syncline (3).

In all, about 400 specimens of *Dickinsonia* have been collected; the vast majority of them are *D. costata* Sprigg. This is now known in growth stages from 7 to over 112 (approximately 120) segments; it is the only form in which some of the internal structures can be demonstrated. Comparison with *Spinther*, the only similar modern worm, shows that *D. costata* is the most generalized of the known Dickinsoniid worms; all other species show, in various more exaggerated forms, a trend to increasing numbers of short segments.

The short-segmented forms initially grouped as *D. tenuis* Glaessner and Wade are considered as three species now that better-preserved material of the narrower forms is available. *D. tenuis sensu stricto* is the broadest. The segments of *D. lissa* sp. nov. are sometimes a little longer (segment length is measured parallel to the axis of the worm), much narrower, and taper less toward their centres than in *D. tenuis*, and more are

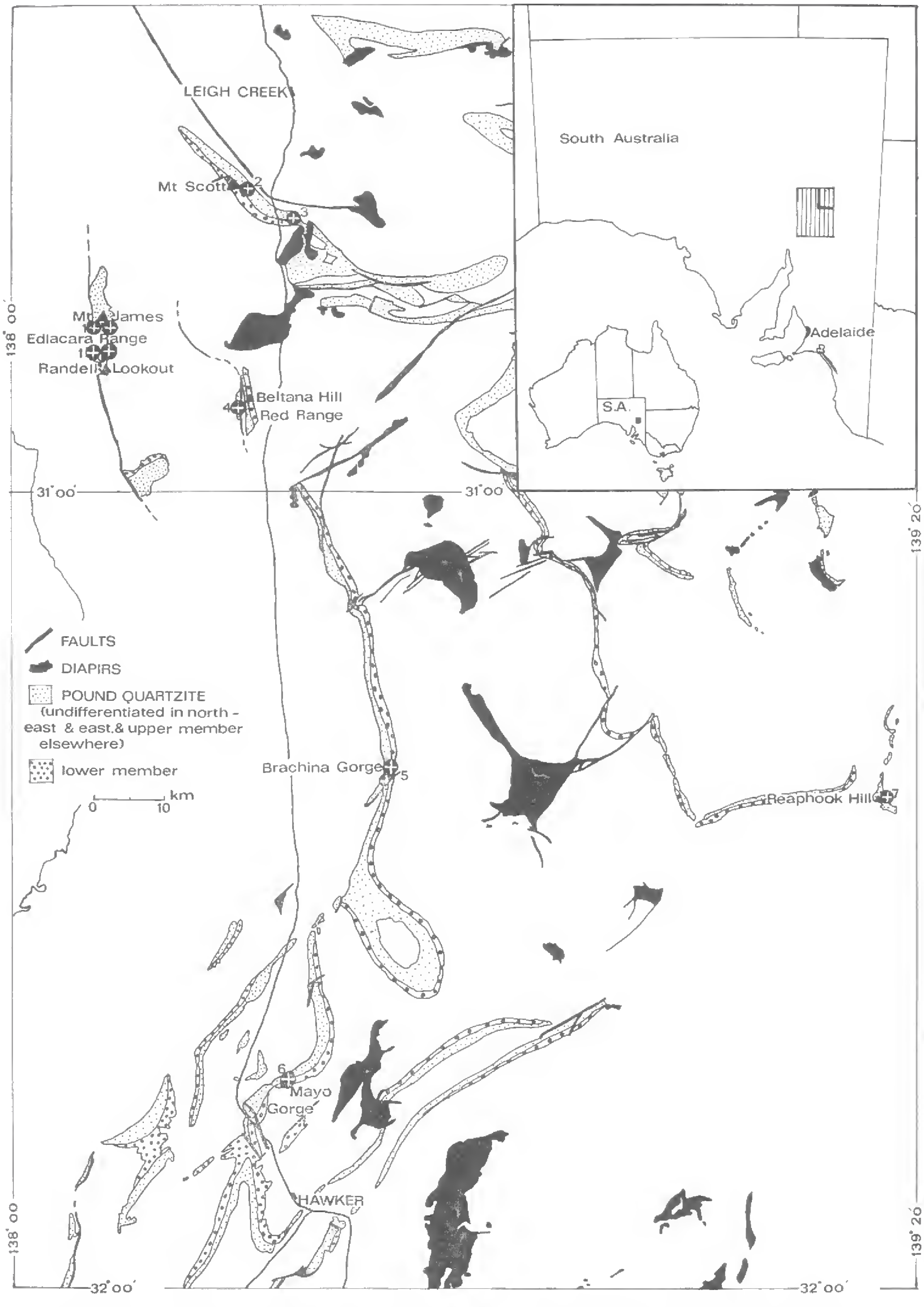

FIG. 1: Locality plan of the Flinders Ranges and adjacent areas showing the presently known distribution of *Dickinsonia*. All known occurrences are low in the upper member of the Pound Quartzite, the Rawnsley Sandstone Member.

transversely placed. *D. brachina* is very rare. It resembles *D. elongata* in all characters except segment length, which is as short as in large *D. lissa*, and its smaller overall size. All but one specimen of the new species (a positive composite mould of *D. lissa*) are at least partly impressions on the depositional bases of rock slabs, as are all *D. elongata* and *D. costata* (except for natural counterpart casts from accompanying impressions). *D. tenuis* and *D. lissa* are the only forms soft-bodied enough to occasionally form casts or positive composite moulds (Wade, 1968, table 1—*D. lissa* is the form referred to as 'unnamed dickinsoniid worm').

Evidence of the worms having been alive where deposited is of two main kinds, (1) worms which have been buried in a state of extreme contraction which is shown by a standard pattern of surface wrinkles produced on the fossils (Plate 5, figs. 3, 4), and (2) worms surrounded by areas from which they have contracted before burial (Wade, 1968, fig. 27; herein, Plate 5, fig. 1). No markings attributable to locomotion are known. The assemblage of five species of these worms is a thanatocoenosis (Wade, 1968, p. 266) and so does not imply that they competed for the same ecological niche.

The worms are here described as seen in latex casts (or in natural positive relief).

DEPOSITORIES. Original material is deposited in the collections of the Geology Dept., University of Adelaide, and the South Australian Museum, save for one each in the collections of R. J. F. Jenkins and a schoolboy collector. Registration numbers commencing T or F refer to the collections of the Geology Department, University of Adelaide, those commencing P refer to collections of the South Australian Museum.

THE SPECIES OF *DICKINSONIA*

I. *DICKINSONIA* WITH RELATIVELY LONG SEGMENTS

Dickinsonia costata Sprigg, 1947

(Fig. 3; Plate 5, figs. 1–8; Plate 6, figs. 1–4)

A complete synonymy of the species was given by Glaessner and Wade (1966). Latex casts of about 100 of the better preserved specimens have been used in this study but practically all of the 350 or more collected have been examined. They come from localities 1–7 on Fig. 1, and the majority remain at The University of Adelaide and the South Australian Museum.

MORPHOLOGY

These worms are flat and elongate-ovate to wider than long. The posterior end is almost always notched at the axis and the anterior end is usually convex but rarely indented. The segmentation is clearly marked on both dorsal and ventral surfaces and the margin is incised between the segments. Segment size diminishes to the posterior, frequently to several times smaller than the more anterior segments. Throughout, the segments are individually longest at their free edges (tips) and shortest at their centres. The most anterior body segment is fused around and in front of the prostomium, and other anterior segments curve forward progressively less (as follows from the centrally-tapering segment shape),

making a series of widening, U-shaped ridges and depressions across the bodies. A variable but not large number of segments are nearly transverse about mid-length of the body, and the posterior segments slope progressively more sharply backward in a series of V-shaped ridges and depressions.

If the area around the posterior notch is well spread out, the most posterior pair of structures are seen to be shorter and broader than the adjacent half-segments, and biconvex (Plate 6, fig. 3, a). As they are always small, nearly flat, and rather obscure it is not possible to be conclusive about the original structure but the shape seen could be produced by flattening a pair of inflated anal lobes similar to those of *Spinther arcticus* Sars (Graff, 1888, as *S.* '*miniaceus*' *vide* Hartman, 1948; Manton, 1967).

Segment surfaces present two main appearances: either they are delimited by furrows continuous from one side of the body to the other (in small specimens these may be indistinct near the centre), or they are clearly interrupted (even in small specimens) by an axial structure of variable width which is broader in more expanded specimens. Expansion is discussed on pp. 176–7. The sides with axially interrupted segments were considered dorsal (Wade, 1968, pp. 262–3), and new material of excellent preservation from Brachina Gorge in the main Flinders Ranges has enabled their notopodial-elytral ridges to be observed more clearly than previously (Plate 5, fig. 2; Plate 6, fig. 3).

Plate 5, fig. 1 shows two fairly large specimens on one slab, both are seen from the dorsal side and they have almost the same number of segments. Both have contracted from their maximum expansion in the place where they were deposited. The larger still appears quite well expanded, its profile is very flat, its septal sutures are not convincingly demonstrable, though their position can be inferred from the incised margins (Plate 5, fig. 2.), and its notopodial-elytral ridges are very sharply defined and end to either side of an axial ridge. This ridge dies out toward the anterior. The notopodial-elytral ridges are mostly folded backward but some are partly bent forward. They broaden rapidly toward their outer ends (notopodial portion) and form a fanshaped tip to each segment. In places these fanshaped tips overlie each other with the more anterior fans above the more posterior. The notopodial-elytral ridges of the first segment are quite widely separated at their inner ends, so that they cannot have reached to the apex of the segment. The ridges of the second segment extend further back but are similarly widely separated at their inner ends, and the following 3 segments also make a group whose ridges do not reach as near to the axial region as the remaining 56 segments. Plate 5, fig. 1 shows on specimen b a small, circular spot that occupies an axial position about the apex of the first segment (at arrow). On the original of fig. 1, a, and fig. 2, a similar spot overlaps a chance lump on the body. It is tempting to regard these circular spots as prostomia or prostomial tentacles like the short, thick 'tentacle' that covers the prostomium itself in *Spinther* but in no specimen is it clearly preserved, and outward expression of the prostomium remains a probability which is very difficult to quantify. It is possible that any kind of lump on or in the body gives rise to a circular 'pressure spot' so that structures in the position of the probable prostomium and/or mouth and pharynx are common in well-preserved specimens, but are often accompanied by similar spots that are haphazardly distributed.

The clearest of the structures possibly representing the mouth (or a wrinkle of extruded pharynx) is shown by the ventral side T50; 2001 (Plate 5, fig. 5; Sprigg, 1949, pl. 2, fig. 4;

refigured Harrington and Moore, 1956, fig. 15, 1b). In this and other specimens the presumed peristome is a short distance anterior to the U-shaped closure of the anterior body segment, i.e. a little anterior to the position of the probable prostomial tentacle seen in dorsal view.

Several ventral sides are of exceptionally good preservation though relatively small, and there are well-preserved portions of the margins of larger ventral-side specimens. Although all have been examined for any evidence of neuropodia it remains inconclusive. Certainly there are no large structures in this region. Some small lumps or flat, round spots near the segments tips could represent neuropodia but they are not constantly present. The two most distinctive examples are Plate 5, fig. 6 and Plate 6, figs. 1, 2. The original of Plate 5, figs. 3, 4 does not show a row of neuropodial bosses at the anterior left, as was initially thought possible, for the similar structures at anterior right occur in 2–3 rows; the zig-zag median furrow on its axial ridge indicates that it is a dorsal side. Some specimens have exceptionally long segments which are therefore large at the tips but these lack evidence of neuropodia. If present, neuropodia must have been small, and not closely related in size to individual segment size. Though it is possible that neuropodia did exist in *D. costata*, it is clear that no relative size increase accompanied the great increase in width of the segments as the worms diverged from a normal polychaete shape. Rather than that, neuropodia probably decreased in size and may have been totally lacking.

Direct evidence of internal structures is rare. Two partial composite moulds indicate parts of paired gastric caeca. One indicates dichotomous branching of the caeca around the pharynx in the anteriorly-curved segments (Glaessner and Wade, 1966, pl. 101, fig. 4). The other has unbranched ridges (on the latex cast) in the mid-body region at right angles to the axis. Judging from the size of faint, segmental ridges in the anterior portion of the body, these caeca would have been spaced one pair per segment, and reached about 4/5 of the distance to the margins of the animal. In this specimen the major structures have less to little more relief than the sandgrains of the rock surface, and it has not been photographed successfully.

Less direct evidence of internal structures is provided by a number of specimens in which an axial ridge is present in the position of the intestine itself. In five specimens (Plate 5, figs. 1–4, Plate 6, figs. 1, 3, 4) the ridge is delimited by sharp furrows on either side. Two of these are relatively well-expanded specimens on which the notopodial-elytral ridges do not reach the axial ridge and one (Plate 5, figs. 3, 4) is intensely contracted. Perhaps these furrows result partly from the action of the most axial dorsoventral septal muscles (p. 176), for Plate 6, fig. 4 shows small pits along the furrow at the sides of the ridge where suture and furrow intersect, and where these muscles could be expected to exert most pull. These furrows are most pronounced on the least and most contracted specimens; on moderately contracted specimens the axial ends of the notopodial-elytral ridges are juxtaposed over the axial ridges (when these are present) and the axial ridges are less clearly delimited, though often quite prominent. As an axial ridge maintains an approximate width related to segment number (i.e. general size) regardless of the degree of expansion or contraction of the bodies, it must be due to an internal structure, and to one that is not always present. It is here considered evidence of a filled intestine.

The musculature of *D. costata* can not be observed directly but some data can be

assembled from studying the effects of contraction seen in some of the fossils. In order of frequency these effects produced:

(1) Worms which have contracted, where later buried, from their maximum expansion by shrinkage inward all around the periphery. Contraction is often greater towards the rear end.

(2) Worms which show one or more strong annulations, the only or outer one of which is a short distance inside the periphery (Plate 5, fig. 3, Plate 6, fig. 3; Sprigg, 1947, fig. 7, pl. 7, fig. 2; 1949, fig. 10, pl. 18, fig. 2, pl. 19, fig. 2; Harrington and Moore, 1956, fig. 14 (1a, c)).

(3) Worms which are transversely contracted, the surfaces of segments being thrown into small crenulations which may be aligned from segment to segment but are interrupted by smooth lines along the sutures (Plate 5, figs. 3, 4). This form of contraction is usually accompanied by (2) but either can occur alone.

It is legitimate to assume the presence of the basic polychaete musculature of circular, longitudinal and septal muscles, and to consider how they may have been adapted as the width of the worms increased. There are several examples of flattened polychaetes (Clark, 1962) in all of which the 4 longitudinal muscles are spread as flat sheets against dorsal and ventral surfaces, and these have strands of dorso-ventral musculature incorporated in the septum. *S. arcticus* (Manton, 1967, figs. 2, 3) carried these adaptions to extreme; the longitudinal muscles have become diffusely scattered strands spaced more or less equally across top and bottom of the coelome, and the septa are represented mainly by dorso-ventral muscles and form sheets only in the upper part of the body below the notopodial-elytral ridges. From its preservation as impressions, *D. costata* was a rather tough worm, and the musculature necessary to move the larger specimens in particular can scarcely have been weak. It seems likely that the reduction of the longitudinal musculature had not proceeded as far in *D. costata* as in *S. arcticus*, but even parallel strips of muscle functionally roof and floor the coelome. Any acceptable model for longitudinal muscle distribution in the flattened, ovate bodies requires the muscles to curve in arcs which become progressively flatter from lateral to medial position. Contraction of these muscles alone would shrink the worm in area and increase its thickness. The two large specimens shown in Plate 5, fig. 1 are of almost the same segment number, the larger has 61 segments, the smaller probably 66. Both contracted *in situ* from their maximum size and were buried at the same time while still fresh. With no other pair of specimens is it possible to eliminate so many of the chance factors in preservation. While the larger specimen has contracted by nearly 2/7 of its width the reduction of its length is only 1/8, its individual segments are quite widely expanded and it has been compressed relatively flat; in comparison, the smaller specimen has more arched segment surfaces, its notopodial-elytral ridges are less regularly disposed, closely apposed in the centre, and the sutures are deeply depressed. In all, the differences between these 2 specimens are open to explanation as due to differing degrees of expansion of the individuals at the time of burial. Both specimens are normally preserved in comparison with other material. As their segment-number is close, the assumption that their fully expanded size would have been similar seems justifiable as a means of roughly estimating normal expansion and contraction. The maximum expansion of the larger specimen was not quite double the

present length and width of the smaller specimen; from this it would appear that a 2 : 1 ratio of expanded to contracted length and width was normally attainable. While strong contraction tended to produce an oval outline, Plate 5, fig. 1a indicates that contraction did not have to be uniform in early stages, at least when the animals were in contact with the ground.

The large-scale wrinkling (2, above) and minor crenations (3) cannot be explained by the action of longitudinal muscles. Circular muscles could be invoked to explain (3) if, as von Graff showed for *S. arcticus* (1888, pp. 31–2, fig. 6, pl. 1, fig. 11), they were not equally distributed. There seems no other likely explanation involving these muscles.

Of the large-scale wrinkles (2) the outer or only one occupies a relatively constant position a short distance inside the edge of the body. Plate 5, figs. 3, 4 show that in very contracted specimens the outer edges are not involved in the major wrinkles or minor crenations. Perhaps this area was formed by the notopodial fans, rather than the body edge, and the first large wrinkle marks the actual body edge (see also Plate 6, fig. 3). If this was so, the notopodial fans were fused together laterally. The muscles effecting this wrinkling are still unidentified but with the total or functional loss of neuropodia many muscles in these areas would have been reduced, lost or transformed in function and structure. Some transverse septal musculature could also have existed.

Growth

The smallest specimen is 3·8 mm long by 3·6 mm wide (Plate 1, fig. 8). It has 7 body segments, 2 angled forward, 1 transverse, 4 angled back toward a small, triangular pygidium. The next in size has 10 segments and is 4·8 mm long by approximately 5 mm wide; 3 of its segments curve anteriorly (Plate 5, fig. 7a, b). As more segments are added, more come to curve anteriorly (Plates 5, 6). Manton (1967) discussed a similar growth-series in *Spinther* in terms of increasing 'cephalization', for there the segment-number is relatively low and at least most of the forwardly curved segments have their central septal musculature involved in everting the pharynx. In *Dickinsonia* the increase in number of curved segments is not adequately described by this term, for the majority of the forwardly curved segments in larger specimens were too far from the pharynx to have been modified, though the more anterior gastric caeca do fuse together at either side of the pharynx, in the only specimen in which they are known. This suggests a comparable degree of 'cephalization' to that attained by *Spinther*. The forward curvature is better regarded as evidence of differential growth rates, the newer segments growing faster than the older ones and forcing them forward. If the newer segments had ceased to out-grow the older ones, forward curvature would have ceased, as happened in *D. elongata* where this change, plus continued growth, results in the immense number of transverse segments and huge size.

As the animals enlarged, the pygidium and pre-pygidial area where new segments were budded off must have increased in overall size also. The surface crinkling of a number of specimens is aligned in fine furrows the outer of which are intraperipheral, while progressively inner furrows arise from just posterior to the earliest segments (Plate 5, fig. 3), to about mid-body; they fade out on the small posterior segments. They are here considered evidence of the formation of increasing numbers of the muscles that contracted to cause the crinkling, as the pre-pygidial zone of segment generation gradually increased in size.

Dickinsonia elongata Glaessner and Wade, 1966

The holotype of *D. elongata* was a juvenile specimen chosen because it was the only one which had both head and tail (Glaessner and Wade, 1966). Two almost complete adults and some more fragmentary specimens have now been discovered at Brachina Gorge and fragmentary specimens at Mt Scott Range and Mayo Gorge (Wade, 1970; this paper, Fig. 1). The smaller of the two is shown on Plate 7, fig. 2; the larger presents considerable difficulty in collecting. It is indistinct at the anterior and lacks the posterior few centimetres. A cast taken *in situ* is 45 cm in incomplete axial length and 17 cm in maximum width; about 280 segments are present. The specimen was first observed high in the cliff, with its complete posterior end exposed on the base of a thick yet badly fractured bed of sandstone and its mid-length to anterior end covered by a moderately thick bed. Since then, a private collector has cleared the lower bed, exposing the whole worm, and tried to chip the fossil from the bed on the base of which it occurs, destroying the posterior end. From memory, only 5–10 cm have been lost; the original worm probably had about 320 to 340 segments. Although fragmental worms which may have been larger than this are known, this is the largest nearly complete worm. The smaller nearly complete specimen was collected by R. J. F. Jenkins, University of Adelaide; its anterior end and most of the body are quite clear, though it is folded over at the posterior after 270 segments (Plate 7, fig. 2). Its probable length was 38–39 cm, maximum width is 13·8 cm. By analogy with *D. costata* this specimen is moderately contracted and in dorsal view. The ridge thought to be due to its intestine is 4 mm wide where its edges are most distinct, 6–8 cm from the anterior end of the worm. The anterior segments are short and narrow relative to *D. costata*, as was suspected from study of the slightly damaged holotype. From the proportions of the anterior segments of T54; 2050 it seems most likely that it is the anterior end of *D. elongata* and not *D. costata* (Sprigg, 1949, pl. 19, fig. 1; refigured (enlarged ×1·45) Harrington and Moore, 1956, fig. 14, 1b; Wade, 1968, fig. 28, illustrated a latex cast).

The holotype shows outer large ridges and folds toward the anterior, and minor crinkles some of which are aligned across the intervening sutures of several segments; these effects of muscular contraction are similar to *D. costata*. Additionally, the holotype and some other specimens show indications of notopodial-elytral ridges. *D. elongata* is thus closely similar to *D. costata* in all its known structures. It has not proved possible to distinguish the two species at small sizes. Presumably growth is prolonged in *D. elongata* which has 3 times as many segments as *D. costata*. The enormous width of some specimens similarly indicates prolonged growth of the whole body but the fact that the segments cease turning forward indicates that, except near the tail, they are all growing at the same rate. There is very little differential growth in length across the width of any one segment, except at the anterior of the animal.

There is no known indication of neuropodia in any specimen. On segment-length alone, it seems improbable that traces would be preserved if they were no more prominent than the possible traces rarely seen in *D. costata*. The retention of a structure already rudimentary at most in the more generalized form, is intrinsically unlikely. The locomotory adaptation seems more likely to be toward swimming than to benthonic movement (pp. 185–6).

II. *DICKINSONIA* WITH VERY SHORT SEGMENTS

In 1966, 16 specimens with very short segments were known, most of them fragmentary. Glaessner and Wade grouped all of them in one species centred on a rather broad form with segments finer than some specimens and coarser than others. Material now available shows that the forms with coarser and finer segments are both consistently elongate in shape, with many segments nearly parallel-sided, while the holotype of *D. tenuis* is almost as broad as long, and has centrally-tapering segments. *D. tenuis* is here restricted to the broad, short-segmented forms resembling the holotype, P13792 (Glaessner and Wade, 1966, pl. 103, fig. 1).

BROAD FORM

Dickinsonia tenuis Glaessner and Wade, 1966

EMENDED DIAGNOSIS: Oval outline; numerous, very short, wide segments taper inwardly so that most slope either anteriorly or posteriorly and few are transverse; dorsal axial line a sharp furrow which may, in composite moulds, traverse a narrow axial ridge (?indicating a filled intestine) that underlies the inner ends of segmental ridges and furrows.

Four specimens are known, all from Ediacara; the holotype, one contorted specimen (Plate 7, fig. 3) decidedly smaller than the holotype, an anterior end of a specimen slightly broader than the holotype, and a posterior end slightly smaller than the holotype. The holotype is a fairly contracted specimen with segments of average length 0·34 mm adjacent to the axis and just posterior to the forward-curved, anterior segments. The anterior fragmental specimen is well expanded and its segments average 0·59 mm in this region. The contorted specimen, P13768, resembles the holotype but it is not possible to be certain which end is anterior and which posterior, as it is folded along the axis at the end which appears to have had the larger segments. This obscures both their actual dimensions and their shape near the axis. The exposed end has rather small segments which are nevertheless U-shaped like an anterior end. Segments average 0·42 mm long adjacent to the axis. The average segment-size for fairly large specimens is thus in the vicinity of 20–30 segments per centimetre in the axial anterior region. At their longest (near the tips) the variable angles of the segment crests provide evidence of notopodial-elytral ridges like those of *D. costata*, although they are too small to be clearly seen. The axis on all specimens is a narrow furrow such as typifies dorsal sides, but on the contorted specimen (Plate 7, fig. 3) this furrow traverses a narrow axial ridge, in proportion as narrow as in *D. costata*.

NARROW FORMS

These *Dickinsonia* are narrower in proportion to length than *D. tenuis* and their segments do not taper toward their centres in a comparable fashion. They vary from a rather rare, evenly segmented form with a relatively narrow axial ridge and relative freedom from local distortions to a form which is generally smaller and generally has shorter segments, a relatively wide axial ridge, and rather variable outlines. The larger individuals of this kind have the same range of lengths and segments/cm as the evenly segmented form.

The question of whether all these short-segmented, elongate forms are one or two species is not easily settled. It is difficult to find comparable measurable characters because of the variability and incompleteness of specimens. Overall length is seldom measurable but relative size can be estimated fairly reliably. The 16 measurable specimens have therefore been lettered in alphabetic order from apparent largest to smallest in Fig. 2 where three characters that can be measured in most specimens are plotted.

(1) the number of segments/cm, measured close to the axis at the first segments not effected by anterior curvature; if it was necessary to take this measurement more to the posterior, where segments may have been slightly smaller, it is marked '?'.

(2) $\frac{1}{2}$W, the maximum width from axis to edge, measured perpendicular to both.

(3) WA, the maximum width of the axial ridge which is attributed to the filling of the intestine.

D has a very narrow axial ridge, which is partly closed to a thin peak by an inward push of the right side (Plate 6, fig. 5). The narrow ridge was a characteristic probably originally shared by A in which its sides are not abrupt but sloping like the compressed part of D, its estimated size is plotted in inverted commas in Fig. 2b. Besides the measurable characteristics, the 3 broadest specimens, A, D and F, have very even, clearly marked segmental grooves. The very flattened F has a broad axial ridge which is probably not wholly explained by spreading due to flattening (Fig. 2b). The remainder of the specimens have furrowing which is regular and appears segmental in some, or is characteristically irregular in others; where regular, it has the same frequency as the average for comparable less regular areas of one specimen, or comparable less regular specimens. Specimen F is to some extent transitional between specimens D and A on the one hand and the remainder of the specimens on the other. On account of its broad axial ridge it is perhaps best to regard it as the member of the main group which most clearly displays its segmentation, partly due to having been well expanded and still quite well preserved at burial. Thus viewed, the elongate, short-segmented *Dickinsonia* with large numbers of transverse segments fall into 2 disparate groups of 14 specimens and 2 specimens (A and D). An additional elongate but very fragmental specimen can also be assigned to the latter group but is too poorly preserved for description; these rare specimens are here described as *D. brachina* sp. nov. The 14 specimens are described as *D. lissa* sp. nov.

Dickinsonia lissa sp. nov.

(Fig. 2; Plate 6, fig. 6; Plate 7, figs. 1, 4)

Dickinsonia tenuis Glaessner and Wade (part), 1966, p. 622.
Dickinsoniid worm. Glaessner and Wade, 1966, p. 628.
Unnamed Dickinsoniid worm. Wade, 1968, table 1.

MATERIAL AND PRESERVATION: 14 specimens from Ediacara Range. One very flattened positive composite mould, 4 partly negative and partly positive composite moulds, and 9 negative composite moulds (including the holotype). The grainsize of the sediment tends to blot out the finer surface features, particularly on small segments.

HOLOTYPE: F17466, from Ediacara Range (Fig. 2, P; Plate 6, fig. 6).

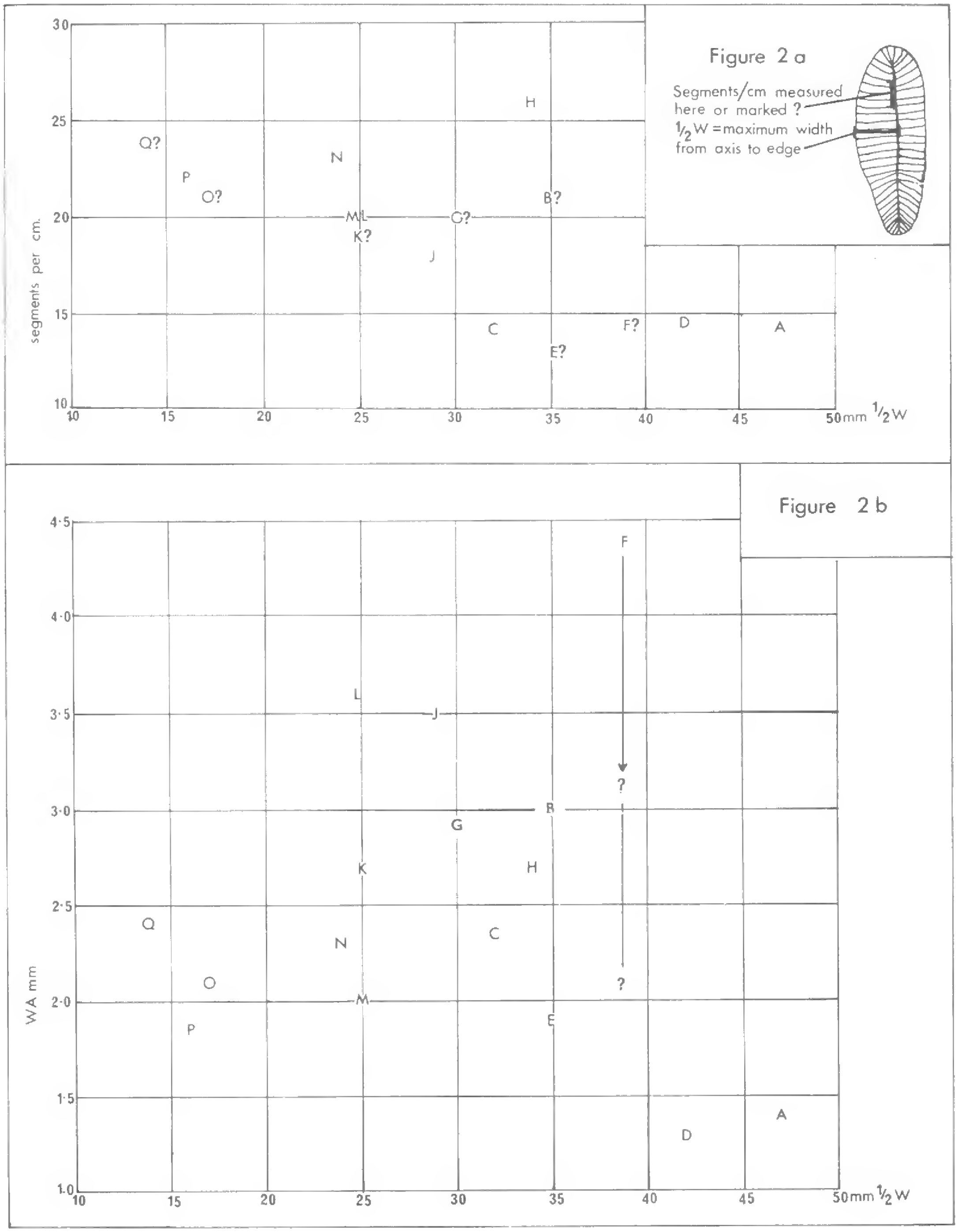

FIG. 2a, b: Dimensions of narrow *Dickinsonia* with short segments. Letters A–H, J–Q indicate specimens in estimated order of length. Whole specimens D, M, N, O, P. Maximum width from axis to edge, ½W. Maximum width of axial ridge, WA. Specimen F is a totally flattened cast and the axial ridge appears to have spread in flattening. If a normal elevation is restored its plotted position on fig. 2b would move along the line indicated to a position between the question marks.

DIAGNOSIS: Elongate, rather narrow *Dickinsonia* with a relatively broad, prominent axial ridge (attributed to a filled intestine) underlying the inner ends of ridges and furrows which may be continuous from side to side or interrupted by a narrow, median depression as they cross the axial ridge (presumably a median depression indicates a dorsal side). Single lappets are sometimes visible at the outer ends of these segmental ridges. The lateral furrows may be irregular in shape, curving forward or back by up to one ridge-width particularly on sides with a median furrow. Where irregular, their average spacing agrees with their spacing in comparable, more regular, portions (most of the irregularity is thought to be due to the tilting of notopodial-elytral ridges).

DESCRIPTION: This species is the most variable in shape, its outlines in apparently undistorted specimens vary from elongate-ovate, widest near the anterior, to lenticular, widest at, or even behind, the centre of the body. Lateral furrows slope forward anteriorly and backward posteriorly, but in between almost half the segments lie nearly transverse in about half the specimens; the other specimens are either too fragmental to observe, or the majority of the segments slope either forward or back, and scarcely any are transverse. There is a prominent axial ridge on all specimens, broad enough to raise the inner ends of the lateral ridges and furrows in every example. On about half the specimens a median depression furrows the ridge and the segmental ridges are interrupted or offset across it (Plate 6, fig. 6; Plate 7, fig. 4). These specimens (Fig. 2, B, H, M, P, Q), are considered dorsal sides from comparison with *D. costata*. Three specimens are too poorly preserved to assess. The remainder of the specimens have intersegmental furrows which cross the axis without interruption and these are considered ventral sides (Fig. 2, C, F, J, L, N, O). On the few specimens which clearly show the edges of the body, the segments end in single lappets which appear to be a little longer than wide. The generally measurable characters have been plotted on Fig. 2 where specimens of *D. lissa* and *D. brachina* are ranked alphabetically in probable order of length. All the entire specimens of *D. lissa* (M, N, O, P on this figure) are in the size range 7·7–9·6 cm but there is an undistorted broken specimen (C) which is 16 cm in axial length and probably lacks 1–2 cm from the posterior end as well as most of one side. This specimen has 14 segments/cm close to the axis and just behind the anterior segments. The other large specimens, B, E, F, are measurable only further back; E and F also have 14 segments/cm but could be expected to have had only 13 segments/cm in a comparable, anterior position. B is very contorted and probably measured quite near the posterior end where it has 21 segments/cm (Plate 7, fig. 4). In general, the smaller specimens have the greater numbers of segments/cm, 26 being the largest number. This character must depend on the comparative size and on the state of expansion of the worms at burial, but the latter factor is self-cancelling as the more expanded worms are longer. A better measurement for size probably would be the total number of segments but there is no specimen in which the smaller segments can be counted, and many have large obscure areas. The number of segments lies between 200 and 300 in all specimens in which it can be estimated.

REMARKS: The very fine segmentation of *D. lissa* sp. nov. has lead to doubts as to whether its lateral furrows were truly segmental (Glaessner and Wade, 1966; Manton, 1967, p. 17). The presence of single lappets (presumably notopodial fans) at the outer ends of the lateral ridges is a strong argument in favour of segmentation. The lateral furrows

have restricted waviness and are noticeably less variable in shape on ventral sides than on dorsal sides. This gives an additional basis for inferring the presence of notopodial-elytral ridges in *D. lissa*.

The plasticity in general shape and in the angles segments make with the axis suggests a softer body texture than *D. costata*, *D. elongata* and *D. brachina*, and this is confirmed by the occasional presence of specimens preserved in positive relief on the bottoms of rock slabs, as in *D. tenuis* (Wade, 1968). The new species is distinguished from *D. tenuis* by its relatively narrower shape and the broad axial ridge attributed to the filling of its intestine. The fact that it is the only species to possess a constant axial ridge suggests it may have been a deposit feeder, while the others inclined more to grazing. It is usually smaller than *D. tenuis*.

The shape of the curved specimen of *D. lissa* (Plate 7, fig. 1) and the differing degree of expression of its anterior and mid-to-posterior segments, without a corresponding variation in the flattening of the edges and axis, suggest that the animal was overwhelmed by sediment while in differing states of contraction along its length, i.e. while still alive. It appears more laterally supple than the representatives of any other *Dickinsonia* species. This, taken in conjunction with the broad and constant axial ridge which suggests a sediment-filled intestine such as is known in many detritus-swallowing worms, makes a benthonic life for *D. lissa* seem very likely. There seems no theoretical limit on the minimum length of segments once there is no requirement for functional neuropodia. A major function of the septal musculature is holding dorsal and ventral sides together against the coelomic pressures engendered by the contraction of longitudinal muscles. The fact that *D. lissa* and *D. tenuis*, the two species whose preservation testifies to the least resistant body-tissues, are also those with the shortest segments suggests that it was profitable for the septa to be more closely spaced in the more delicate worms in particular.

Dickinsonia brachina sp. nov.

(Fig. 2, A, D; Plate 6, fig. 5)

Dickinsonia tenuis Glaessner and Wade (part), 1966, p. 622.

Material and Preservation: One large partial specimen and possibly some small fragments from Ediacara Range. One whole and one fragmental specimen from Brachina Gorge. All are impressions on the bases of sandstone slabs.

Holotype: F17467 from Brachina Gorge (Fig. 2, D; Plate 6, fig. 5).

Diagnosis: Elongate, narrow *Dickinsonia* with many transverse segments of similar width which do not taper toward their centres and which are less than half the length and width of comparable segments in *D. elongata*, so that the individuals are much smaller for a comparable segment-number. Axial ridge (?due to a filled intestine) relatively narrow.

Description: Only the holotype is complete, the partial specimen from Ediacara lacks most of its natural edges, part of its anterior end, and all the posterior end but its partial length is as long as the holotype. In both, the anterior segments are small and later segments increase in width for about one fifth of the body length, then reaching a near-constant width which is maintained until the segments commence to diminish in size (both length and width) toward the tail. As the length of all individual segments is practically constant

across their width, the segments are very slow to lose their forward curvature at the anterior and mid-body region, and slow to gain a posteriad slope at the tail. An axial ridge which uplifts the segmental ridges and furrows of the holotype is roughly constant in width at the anterior (1·3 mm) but pinched in the central part of the body where the right side is thrust slightly inward. The axial ridge is slightly wider (2 mm) in the tail region but as this would be the rectal part of the gut in *Spinther* there is considerable ground to suspect that this measurement would not be comparable with the others plotted as width of axis (WA) on Fig. 2, so the measurement taken at the anterior (1·3 mm) has been plotted for specimen D. The axis of the larger specimen (A in Fig. 2) is also elevated, its axial region in general is rather obscure but seems to have been only slightly broader than in the holotype. The holotype and probably the larger specimen are ventral sides. Only the holotype has its edges well enough preserved to show single lappets at the segment tips.

REMARKS: In its remarkably even length of individual segments this species resembles *D. elongata* although the fact that its early segments also scarcely taper toward their centres results in a relatively prolonged anterior curvature of the segments. Like *D. elongata* the body is of relatively constant width for half or more of its length. The resemblance between *D. brachina* (Plate 6, fig. 5, $\times 1$) and *D. elongata* (Plate 7, fig. 2, $\times \frac{1}{2}$) is exaggerated by the difference in magnification. The segments are vastly shorter than those of *D. elongata* and of comparable length to those of *D. tenuis* and *D. lissa*. They differ from those of *D. tenuis* by their constant individual length, as those of *D. tenuis* taper strongly toward their centres. The segments of large specimens of *D. lissa* have much more in common with *D. brachina* although they are not as regular and much more prone to local distortions, as if the bodies were softer. The principal measurable difference between *D. lissa* and *D. brachina* is that *D. brachina* has a much narrower axial ridge for its size than *D. lissa* (Fig. 2; contrast specimens A, from Ediacara, and D, the holotype, with the remainder of the specimens, all of which are attributed to *D. lissa*).

LOCOMOTION

Locomotion of errant polychaetes normally involves alternating waves of contraction of left and right longitudinal muscles (Chapman, 1958). This is aided by a 'power stroke' from the parapodia in at least several swimming forms (Clark and Clark, 1960); a similar movement is characteristic of walking forms. Sinuous lateral movement and parapodial locomotion are ruled out by the shape of *Dickinsonia* and the absence or reduction of its parapodia. Almost the only form of benthonic locomotory movement available to a worm of this shape appears to employ peristaltic waves of compression and extention. This requires functional septa, or a combination of septa and other structures which hinders the flow of coelomic fluid enough to allow temporary high pressure gradients to extend the animal. The usual posteriad slope on the notopodial-elytral ridges suggests that they were rigidly supported by spines and had 'roots' forming a septum in the upper part of the body like *Spinther* (Graff, 1888; Manton, 1967; the paper of Drasche, 1885, to which Manton referred is not available to me). The major part of any obstruction to coelomic flow would have been played by the septa. In *D. costata* the gastric caeca occupy perhaps half the length of the inner parts of segments in which they lie but much less toward the broad tips,

and they do not appear to reach to the edge of the body. There is no direct evidence of any other intra-coelomic structures but the worms were often surprisingly resistant to compression. They possibly contained a high proportion of 'glandular and other tissue and cells' as Manton (1967) and von Graff (1888), whose beautiful illustrations also show enormous masses of eggs or testes in the coelome, brought out in their descriptions of *Spinther*. In this event, the reduction in volume of the coelomic space in a contracted segment may have been enough to render the 'space' filled with cellular tissues, that is, a functional barrier to fluid movement, which did not require complete septa. The dorsal mesentery plus intestine would tend to provide a longitudinal barrier of more importance in worms with lateral movement like *D. lissa*.

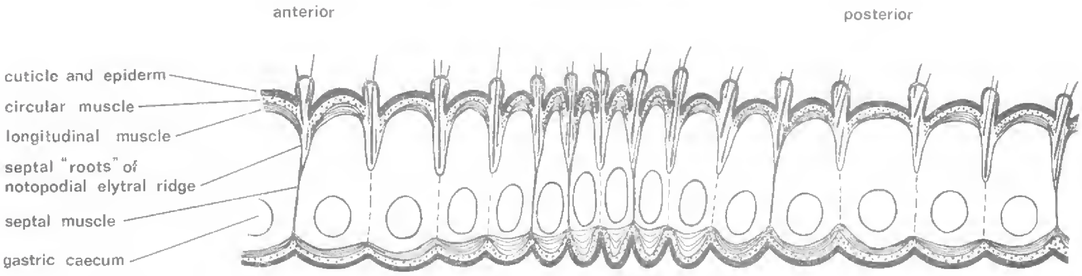

FIG. 3: *Dickinsonia costata* Sprigg, approximately ×5. Hypothetical section to side of axis behind the anterior region, showing a wave of contraction passing from posterior to anterior. Based upon the 2 large specimens shown in Plate 5, fig. 1, the two composite moulds showing gastric caeca, and, for details of musculature, the modern polychaete *Spinther*. Simplified by omitting the gonads and other probable intracoelomic bodies which occur in *Spinther* and of which there is no evidence in the fossils.

Fig. 3 is a hypothetical longitudinal section of *D. costata* showing alteration in shape of segments during a wave of contraction. It is sited about mid-body and to one side of the intestine. The proportions of the notopodial-elytral ridges and the segments are restored from the larger specimens shown in Plate 5, fig. 1, and those of the gastric caeca from the specimen figured by Glaessner and Wade (1966, pl. 101, fig. 4) and the unfigured composite mould. The thickness of the body walls and depth of the septal roots of the notopodial-elytral ridges have been restored by comparison with *Spinther arcticus* (Graff, 1888; Manton, 1967); speculative intracoelomic structures have been omitted. It can be seen that, during contraction, several very incomplete septa plus intra-coelomic structures must have interposed a considerable baffle to the flow of coelomic fluids, and that if the contractions passed forward at a normal rate for polychaetes, 'leakage' through the incomplete septa could be needed to prevent overlarge pressure build-ups. In the diagram the lower surface has been shown as if flattened against the sea floor, because this must frequently have been the case. Although this may have been the main mode of locomotion of the early Dickinsoniids, and probably was the feeding locomotion of *D. costata* and more specialized forms, a rapid series of contractions would be quite likely to cause tapering segments to expand unequally and ripple the edges of the body so that the animals would tend to lift from the

sea floor. *D. costata* probably swam as Glaessner (1961) suggested. This is a possible type of swimming locomotion for *D. tenuis* which is the same general shape.

Increase in size frequently accompanies increased locomotory ability with its advantages for finding suitable feeding areas. It is hard to imagine a suitable food for *D. elongata* which was not obtained by grazing or detritus-swallowing, either of which would require benthonic movement of an errant polychaete, but the elongate, tough bodies seem particularly well adapted for swimming by waves of up and down contractions like a leech I have observed swimming with this motion, its body flattened dorsoventrally as described by Chapman (1958). If sinuous up and down movement also developed, some of the worms could have been quite rapid swimmers. This may be the reason why large numbers of equal, transverse segments arose, probably by convergence, in *D. elongata* and *D. brachina*. The ribbon-like and large *D. elongata* was morphologically so close to *D. costata* as to be indistinguishable from it unless 50 to 100 segments were present. *D. brachina*, like *D. elongata*, had a ribbon-like body with large numbers of near-equal segments between anteriorly curving head segments and posteriorly-curving tail segments; its extremely short segments suggest an affinity with *D. tenuis*. Small growth stages are not known from either species but extrapolation from the growth stages showing in the adults suggests even greater similarities between their young.

D. lissa, also possibly derived from the more generalized *D. tenuis*, may well have been benthonic (p. 183).

RELATIONSHIPS WITHIN *DICKINSONIA*

As in any group of five allied species from one short time-interval it is possible to argue about the similarity indicated by the distribution of characters. The systematic

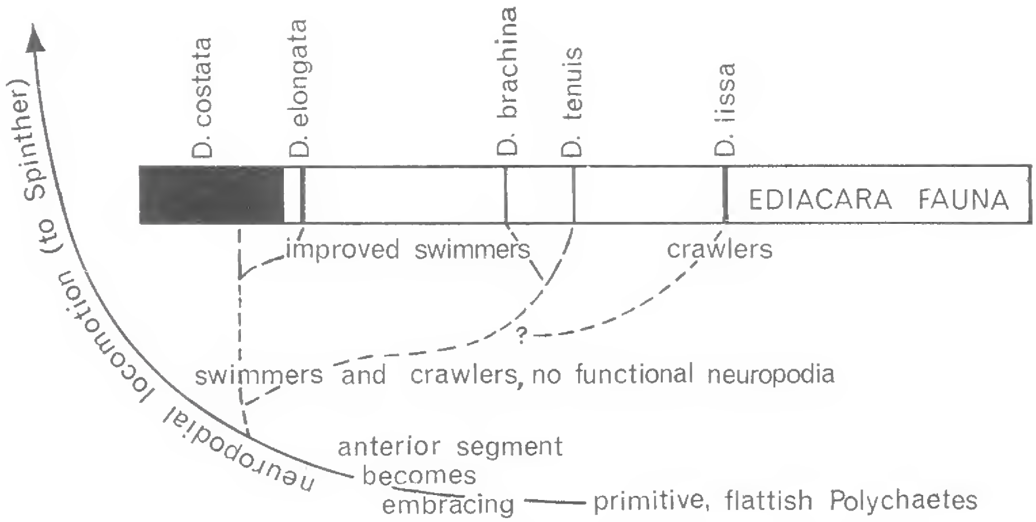

FIG. 4: Similarities and differences between the 5 known species of *Dickinsonia* expressed as a phylogenetic diagram. Relative frequency in the Ediacara fauna is represented by the width of the vertical black lines.

importance of the broad, consistently convex 'intestine' of *D. lissa* is endlessly debatable for the characteristic may not be very different from the relatively narrower and sometimes convex 'intestines' of the other species. Fig. 4 gives a preliminary assessment of the relationships. *D. costata* and *D. elongata* form one group on grounds of structure, segment-size and ontogeny. *D. brachina* and *D. tenuis* are almost equally close for comparable reasons if the segments are accepted as a record of ontogeny. *D. lissa* seems close to *D. tenuis* morphologically but the evidence of a broad, filled intestine and lateral suppleness suggests a more decided adaptation to benthonic life than any of the other species show. *D. lissa* has not sufficient preserved morphologic differences to be separated generically from the other species at this stage of our knowledge.

RELATIONSHIPS OF *DICKINSONIA*

Manton (1967) pointed out that 'The only mechanically convenient manner of obtaining great width to a flat segmented body is for the lateral parts of the anterior and posterior segments to fan forwards and backwards respectively. . . . By this expedient parapodia lie all around the margin of the animal and there is no extraordinary wide anterior face to the most anterior segment or posterior face to the most posterior segment.' This arrangement of parapodia has been achieved by ontogenetic increase in 'fanning forwards of the lateral parts' of the anterior segments in *Spinther*. As can be seen in many illustrations (e.g. in Day, 1967) this structure is incipient in the head region of many relatively broad worms, Palmyridae and Amphinomidae in particular. It has also been achieved (with loss of segmentation and concentration of musculature) by the Myzostomia. *Spinther* and *Dickinsonia* alone are known to have reached the limit possible to a segmented polychaete, complete fusion of the most anterior body segment along a line of contact anterior to the prostomium. This has allowed the anterior segments to achieve a relatively large size. For a mobile worm, there are advantages in not greatly diminishing (and weakening the musculature in) the anterior segments, advantages which would be greater the larger, and particularly the broader, the worm. The combination of selection for flatness and mobility seems enough to explain the encircling of the prostomium by the first body segment though size increase could also have played a part. Once the new adaptation was initiated, size increase in constant or broadening proportions would be sufficient to force the replacement of neuropodial locomotion. This order of events is suggested by the retention of neuropodial locomotion in *Spinther* and its loss in *Dickinsonia*.

The question of whether encirclement of the prostomium arose once or twice in the lines of *Spinther* and *Dickinsonia* could be debated on the ground that the detailed anatomy of *Dickinsonia* is poorly known, but the positive evidence is of relationship. The notopodial-elytral ridges are very similar and so are the gastric caeca, and the evidence for prostomia and mouths also points to a relationship. As *Spinther* is still specialized for neuropodial locomotion, though relatively inactive, and its 12-segment young stage described and figured by Manton (1967) is much less broadened than adult *Spinther* or the smallest known *Dickinsonia* (Plate 5, figs. 7, 8), the separation of these two stocks must have pre-dated the Ediacara fauna. Even at that date the habit of grazing on sedentary fauna was available to a rather small worm, though too restricted for a large and active form (Fig. 4). Its adoption

would almost guarantee the inhibition of locomotion in any group of worms taking it up. The differences between *Spinther* and *Dickinsonia* are thus most likely to have arisen by the ancestors of *Spinther* adopting an ectoparasitic life-habit which kept them small enough for neuropodia to function, and for which slow locomotion was adequate. This life habit has been available ever since. The particular niche favoured by the present species, which shelter and graze on sponges and within their larger cavities, has been available at least since Early Cambrian, and probably much longer. Other members of the ancestral group, probably spurred by size increase and certainly in an environment then free of predators on large, unarmed invertebrates, developed the new locomotion which characterized the Dickinsoniid line and permitted morphologic changes coupled with the diminution and loss of neuropodia. The temporary success of the innovation is indisputable but the niche for large, exposed and almost defenceless creatures was shortlived. The group does not appear to have been present at the time of formation of Early Cambrian sandstones lithologically similar to the Pound Quartzite.

As total morphologic obliteration of neuropodia is not certain in *D. costata* and is unlikely in its close ancestors, it is debatable whether *Dickinsonia* and *Spinther* are distinct at family level but the names Spintheridae Augener, 1913, and Dickinsoniidae Harrington and Moore, 1955, have already been coined and are useful for characterizing forms of such different life-habits that iterative evolution is extremely unlikely. The Amphinomidae, close to which *Spinther* is usually arraigned, include a large percentage of epifaunal browsers, but as Manton (1967) pointed out, the (basically relatively simple) proboscis of *Spinther* does not resemble any of the amphinomid or other polychaete stomodea illustrated and discussed by Dales (1962). Although it is less muscular and more voluminous, it is much closer to the *Myzostomum* stomodeum as figured by von Graff (1884, 1887; his monograph, 1877, is unavailable to me). This, of course, is even more dependant on protrusion by muscles than that of *Spinther*, as parenchyma replaces the (part-filled) coelome. The Myzostomia are much more specialized for parasitism than Spintheridae and their parapodia have evolved in a very different fashion; there is no suggestion of an ancestral relationship which merely pre-dated their loss of segmentation, rather, the similarity of the stomodea suggests a primitive stomodeal form which may have been quite wide-spread in the early Polychaeta. Myzostomid galls have been found in some quite early crinoids, so both these groups have respectably long time-ranges, the range of the Myzostomia being at least Ordovician–Recent. Manton considered *Spinther*'s stomodeum to be a specialized result of its ectoparasitic habit, so a careful comparison is required to evaluate the possibility of convergence in these two groups of ectoparasites.

If an ordinal subdivision of Polychaeta such as that recommended by Dales (1962) is used, Spintheridae and Dickinsoniidae presumably require their own order: Dickinsoniida Harrington and Moore, 1955, is available. Against this is the opinion of Day (1967) and others that no clear picture of major polychaete relationships has emerged. Evaluation of the taxonomic categories which portray the similarities and differences of *Spinther* and *Dickinsonia* can really be carried out only in the context of a thorough revision of 'Errantia' or Polychaeta in general, but their systematic position close to a root-stock which possibly included amphinomid and myzostome ancestors seems most probable.

Termier and Termier (1968, pp. 62, 150–1) proposed that *Dickinsonia* might represent an intermediate between the turbellarians and the molluscs, arthropods and (through *Tribrachidium* as a 'nymphoid') the echinoderms. *Dickinsonia* is quite unequivocally placed as a generally primitive polychaete, specialized in respect of its broad, flat shape, encircled prostomium, and its locomotion, but derived from ancestors with biramous parapodia and a more normal, narrow, elongate shape (characteristics of which *Spinther* provides living evidence). It cannot be regarded as a more likely candidate than any other polychaete for a 'missing link' which may unite all phyla with trochophore larvae (or derivatives) to a more primitive group. The Ediacara fauna in general appears too young to be the repository of links between many phyla. Coelenterates, annelids and arthropods were quite diversified by that time (Glaessner, 1971).

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PLATE 5

Dickinsonia costata Sprigg, all figured from latex casts of natural moulds.

FIG. 1: ×0·5. a–c, 2 adult and one juvenile specimens, all in dorsal view. Shrinkage marks encircle a and b, and arrows indicate their possible prostomia. Small *Parvancorina minchami* Glaessner occur at upper left and right. F17462–4; a–c respectively.

FIG. 2: ×1·3. Anterior right of fig. 1, a, showing notopodial-elytral ridges which broaden near segment-tips, possible prostomium between arrow and bracket, and groove on left of axial ridge at lower right. F17462.

FIG. 3: ×1. Intensely contracted specimen. Large, concentric wrinkles near periphery and fine crenulations many of which are aligned into fine ridges and furrows that increase in number on the axial side from anterior to mid-length. P14375.

FIG. 4: ×2. Anterior left of fig. 3. Overlapping notopodia and outer ridge. P14375.

FIG. 5: ×2. Anterior of ventral side. Possible edge of pharynx at rear end of first segment. T50; 2001.

FIG. 6: ×2. Ventral side showing faint circular marking near tips of larger segments. F16725.

FIG. 7a, b: ×5. Juvenile with 10 segments and pygidium; a, unaltered photo, and b, segments inked in from examination of cast. P12774B.

FIG. 8: ×5. Juvenile with 7 segments and pygidium, segments inked in from examination of cast. F17465.

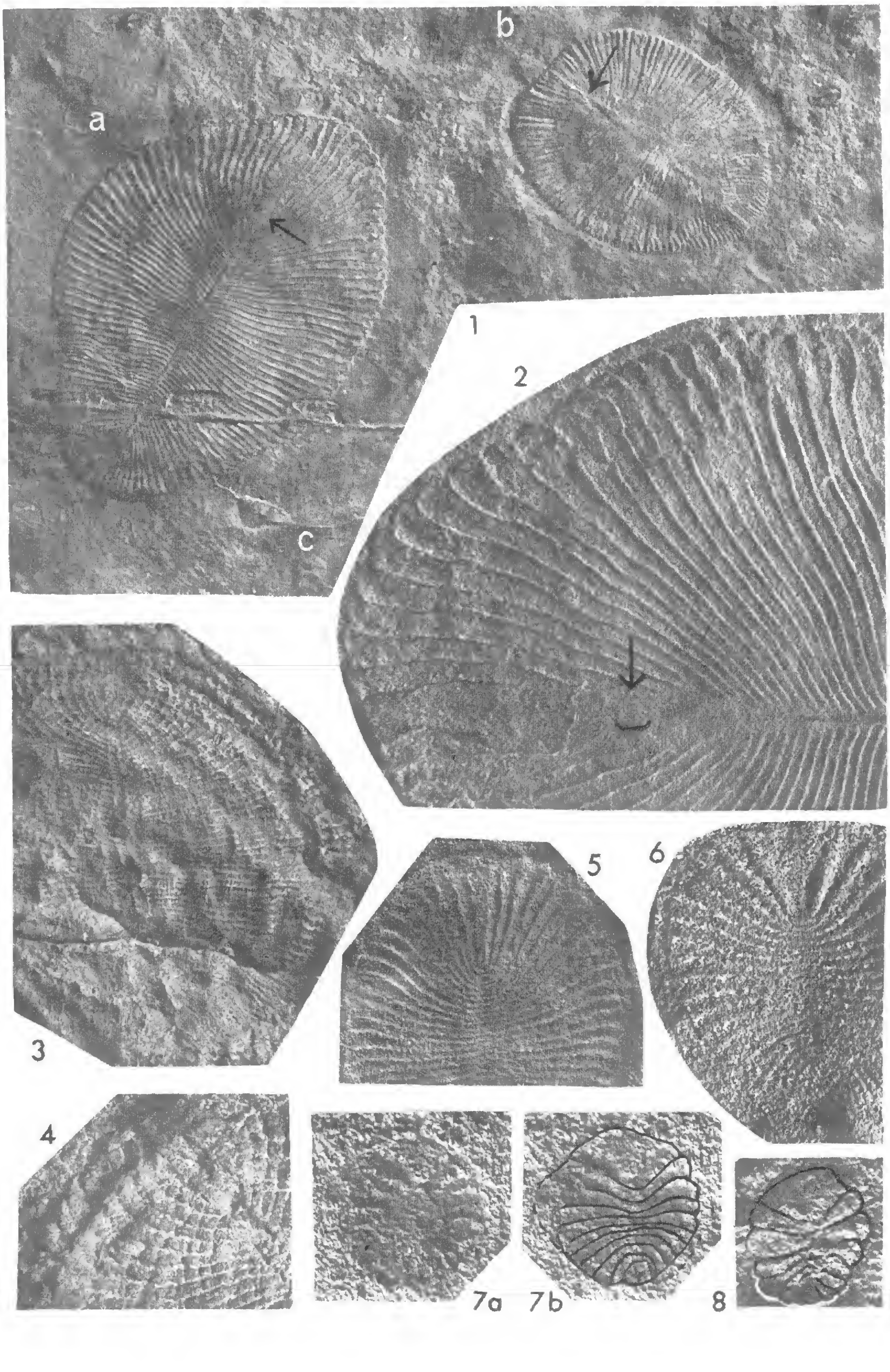

a
b
c
1
2
3
4
5
6
7a
7b
8

PLATE 6

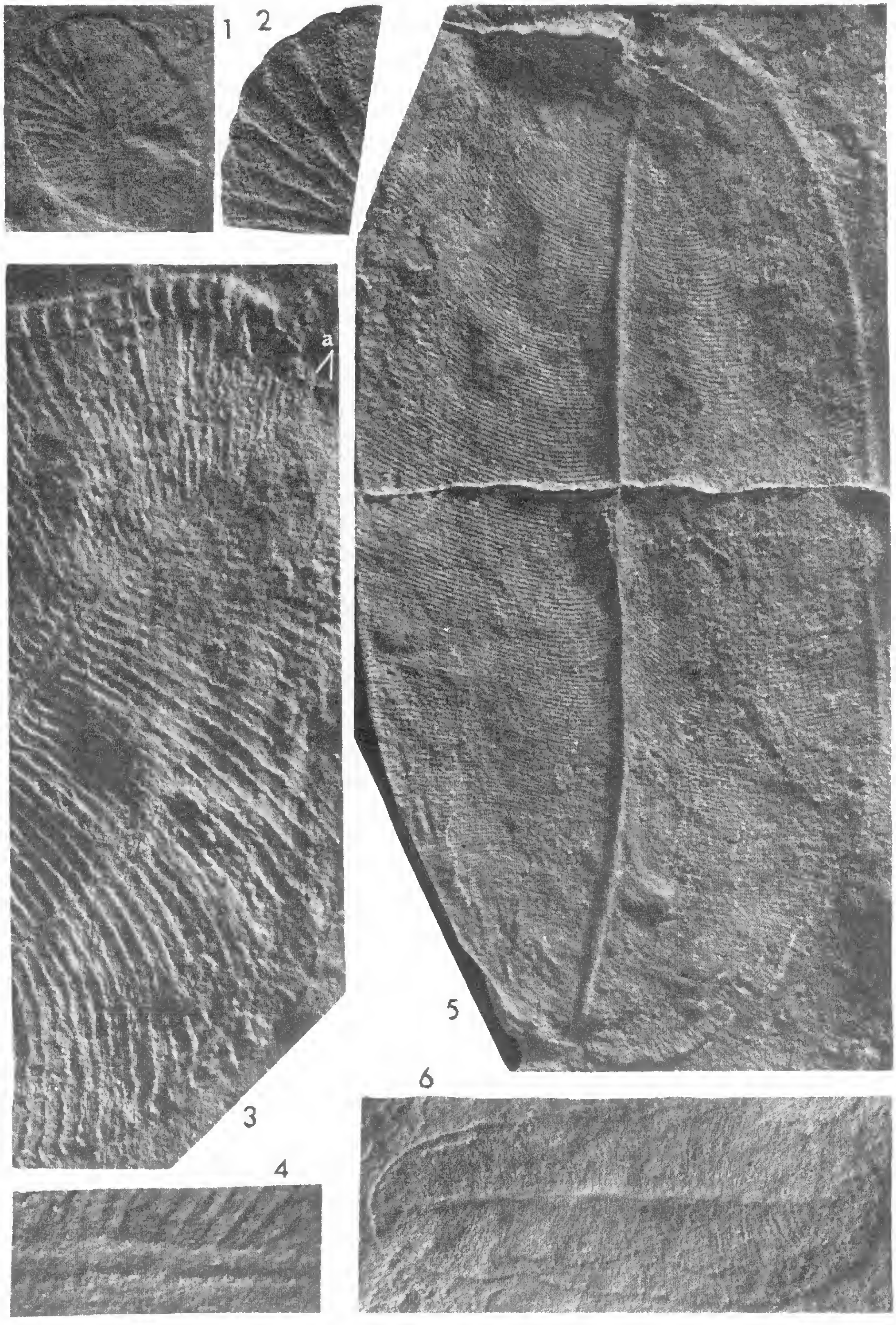
All figured from latex casts of natural moulds.

FIGS. 1, 2: ×1, ×2. *Dickinsonia costata* showing slight lumps at end of larger segments. Anterior up. F16717.

FIGS. 3, 4: ×1, ×2. *D. costata*, anterior to left. 3, Showing notopodial-elytral ridges and (above) near-periperal wrinkle; a, possible anal lobes. 4, Axial ridge bounded by grooves showing a series of small depressions as frequent as the segments. Private coll.

FIG. 5: ×1. *Dickinsonia brachina* sp. nov., holotype, ventral side showing near-constant length of segments across their width, and large numbers of transverse segments. A slight indenting of the right side has curved these segments and pinched the narrow axial ridge. F17467.

FIG. 6: ×1. *D. lissa* sp. nov., holotype, dorsal side. Anterior to right. F17466.


1
2
a
3
4
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6

PLATE 7

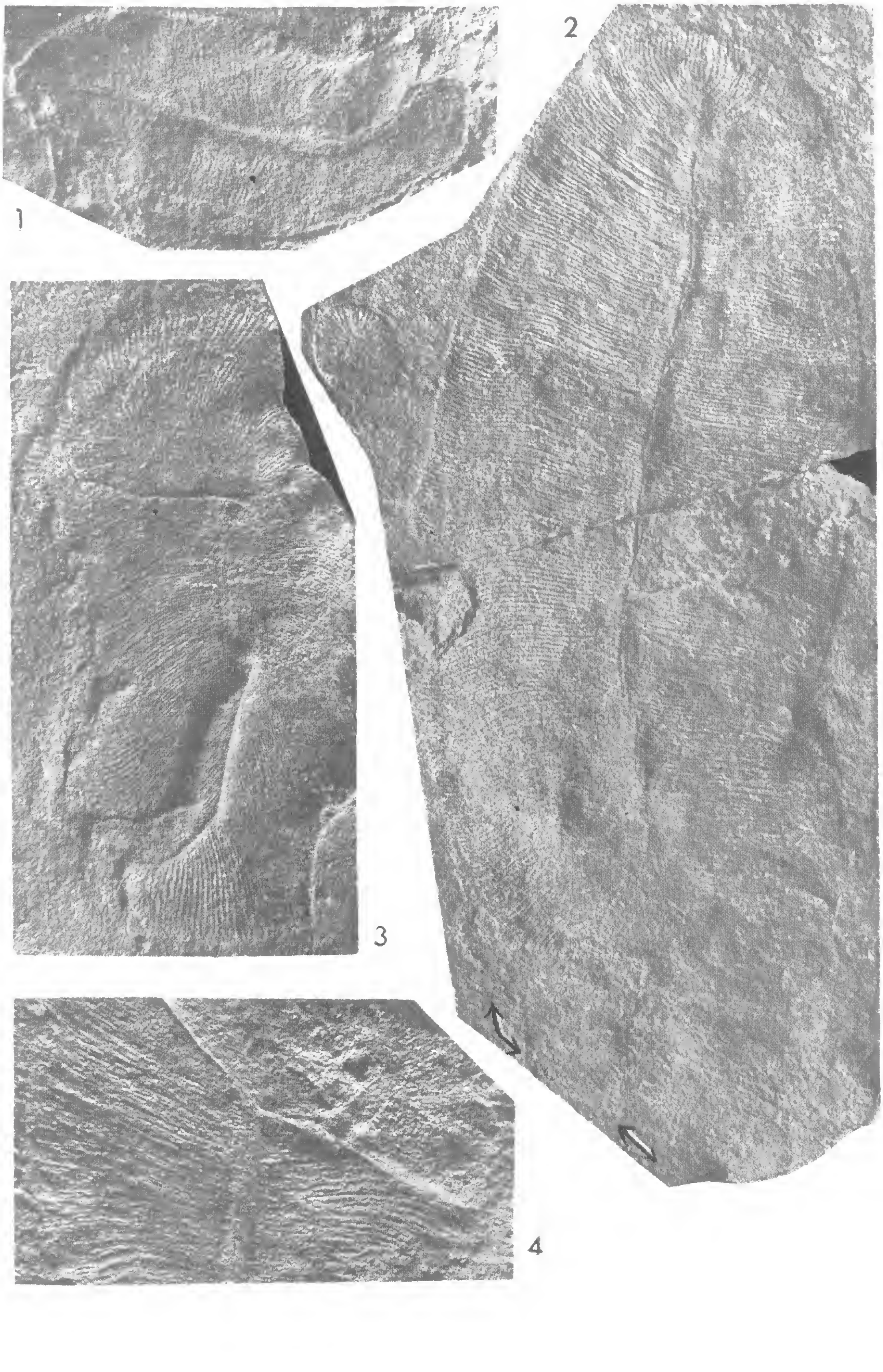
All figured from latex casts of natural moulds.

FIG. 1: ×1. *D. lissa* sp. nov., paratype, ventral side, showing lateral curvature of anterior end at right, and little sign of sutural ridges in curved portion though relief is constant. F17036.

FIG. 2: ×0·5. *D. elongata* Glaessner and Wade almost complete dorsal side showing anterior end (up), posterior end folded along arrowed line. *D. costata* occurs at left on this slab. Jenkins coll.

FIG. 3: ×1. *D. tenuis* Glaessner and Wade, previously unfigured paratype. Showing narrow axial ridge with dorsal furrow in centre of body, and centrally-tapering segments. P13768.

FIG. 4: ×1. *D. lissa* sp. nov., paratype. Specimen showing axial ridge with 'median' furrow and characteristically irregular appearance of segments on dorsal side. P14325.


1
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Mem. Qd Mus. (1972) **16**(2): 191–209.

AN EXAMINATION OF THE CLASSIFICATION OF SOME AUSTRALIAN MEGASCOLECID EARTHWORMS (ANNELIDA: OLIGOCHAETA) BY NUMERICAL METHODS

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ABSTRACT

Forty-nine species of Megascolecid earthworms (Annelida: Oligochaeta: Megascolecidae), at some stage included in the genera *Plutellus* Perrier and *Woodwardiella* Stephenson, were examined by numerical methods using information statistic and Euclidean strategies. Both dendrograms and ordinations were obtained, and the groupings seen in these agreed to a large extent with groupings recently proposed by Jamieson. In an attempt to assess the contribution made to the classification by four quantitative attributes (ratios of intersetal distances to body circumference), the programmes were repeated without these attributes; their removal had little effect on the results at the 'probably generic' level, and a slight effect on the intensity of clustering above this level.

The Australian Megascolecidae (Oligochaeta) are at present under review by Jamieson. Part of this work (1970, 1971a, c, 1972a, b, c) examines the relationships among species previously placed in (or ascribable to in the case of new species) the genera *Plutellus* Perrier and *Woodwardiella* Stephenson. Comparisons between members of the two genera have not previously been made, despite obvious similarities among some of the members, because of the importance attached to the 'key' character of prostate morphology. (In a similar way comparisons between groups with conflicting setal arrangement is rarely attempted.) The present study takes advantage of Jamieson's groupings to test the usefulness of numerical methods of taxonomic analysis in a review of this nature. Computer programmes for mixed-data taxonomic analysis are available in Australia, and as the number of Australian Megascolecid species is large (Jamieson, 1971c lists 247, and most collecting in uncollected areas yields undescribed material), a numerical method of analysis would be an advantage.

The Group under Study

The type-species of the genus *Plutellus*, *P. heteroporus* Perrier, is enigmatic, and almost a typological classic. It was described in 1873 from two specimens in the Paris Museum, collected over fifty years before (Macnab and McKey-Fender, 1948). Its locality was given as Pennsylvania, but no similar material has since been collected from that region. The validity of the type-locality has been questioned by Gates (1961, 1962) on zoogeographical

grounds, and by Jamieson (1970), who shows a close morphological similarity between *Plutellus heteroporus* and the New South Wales *P. manifestus* (Fletcher); Paris Museum collections included Australian material at the time Perrier was working.

The more obvious morphological features of *P. heteroporus*—the 'lumbricin' setal arrangement (eight setae per segment), tubular prostates emptying as a single pair of male pores with the male ducts on segment XVIII, and the holonephric nephridial system—were regarded as distinctive, and became the necessary characters for admission into the genus. Michaelsen (1900) gathered into the genus all material satisfying these requirements. This included North American material formerly of the genus *Argilophilus* Eisen, Australian material formerly *Cryptodrilus* Fletcher, *Megascolides* McCoy, and *Notoscolex* Fletcher, and two Ceylon species of *Megascolides*. The Australian genus *Fletcherodrilus* Michaelsen was added to the group by Michaelsen (1910) despite the fact that its male pores were unpaired.

Since then, other authors, in particular Gates and Macnab and McKey-Fender, continued ascribing new material to the genus, though always noting the need for revision, until the number of species reached approximately 105, with a distribution including Australia, Tasmania, New Caledonia, New Zealand, Auckland Islands, Queen Charlotte Island, the Pacific Coastal strip of North America, Guatemala, northern South America, India, Ceylon and Burma (Jamieson, 1971c).

Gates (1961) considers oriental species to be distinguished by a lack of calciferous glands, and Burmese species to be possibly congeneric with these; in 1962 (p. 187) he regards the genus as 'a congeries which has in common only the two characters of its family (Acanthodrilidae, *sensu* Gates) and in addition the lumbricin arrangement of the setae', and its distribution 'as incongruous as the morphology'. McKey-Fender (1957, p. 58) notes that 'so much remains to be done, of even a very elementary nature in the study of this genus'. The fact that the problem was not immediately seized upon is probably indicative of the very small number of taxonomists interested in oligochaete classification.

The first contribution to a revision of the genus was made by Jamieson (1970), who found clear indications of morphological affinities between *Plutellus manifestus* and certain members of the genus *Woodwardiella*, to which he gave generic status as *Heteroporodrilus*. The two genera, because of their possession of different types of prostate gland structure, had previously been placed in different families (the Acanthodrilidae and Megascolidae, *sensu* Gates, respectively). Jamieson proposed that *Plutellus* be restricted, possibly to contain only *P. manifestus* and *P. heteroporus*, that *Argilophilus* be reinstated for the North American species, and that the rest of the genus be examined for further groupings. *Fletcherodrilus* was later reinstated (Jamieson, 1971c), and a new species described from Lord Howe Island, previously ascribable to *Plutellus*, was given the new name of *Paraplutellus* Jamieson, 1972a.

The next stage in the breaking-down of the Australian *Plutellus* was the grouping of a number of species with Victorian distribution under a new generic heading, *Simsia* Jamieson, 1972a, b. Within this grouping he showed some species to be synonymous—*Megascolides steeli* Spencer with *Simsia manni*, *M. attenuatus* Spencer and *M. incertus* Spencer with *S. minor*, and *M. roseus* Spencer with *S. tuberculata*. The Western Australian species were separated off as a genus, *Graliophilus*, within which five species-groups are defined (Jamieson, 1972c). The most distinctive of these groups, the '*georgei*' and '*strelitzi*' groups, are suggested to be of possibly generic status.

Of the Australian *Plutellus*, this leaves some seventeen species unplaced, although the number for which material is available is now considerably less than this. In order to examine the affinities of Australian *Plutellus* species, this study included as many as possible of the following: *Heteroporodrilus* and *Woodwardiella* sens. strict. members; Australian, North American and oriental *Plutellus* (*sensu* Michaelsen) members; *Fletcherodrilus* and *Paraplutellus*. This group was entitled for the convenience of the study, the 'plutelloids'.

Previous Applications of Numerical Taxonomy to Oligochaetes

Three authors have applied numerical methods in revising Oligochaete classifications. Sims (1966, 1969) used the methods of Sheals (1964) to study relationships agmonst 29 Megascolecid genera, and achieved a classification similar to that proposed earlier by Gates (1959). Sims's work is interesting as a tentative application of numerical methods to an Oligochaete classification and it is cited by Mayr (1969, p. 211) as a demonstration of 'the utility of the phenetic approach'. However it has been criticized by Lee (1970) for its use of inappropriate taxa, and Sims's interpretation of results have been shown to be susceptible to a different interpretation by Jamieson (1971b). In a later paper (1971) Sims applied similar techniques to a classificatory problem in the family Eudrilidae. He effectively demonstrates the futility of classificatory schemes based on intuitive emphasis on a particular characteristic, at least in this family, where affinities based on any one structure have no correlation with affinities based on other structures.

Lee (1970) in an analysis of New Zealand Megascolecidae, avoided the faults he saw in Sims's treatment of the family by employing a more comprehensive taxa list. He used the information statistic of Lance and Williams (1967), and obtained groupings which substantially endorsed his own earlier (1959) classification.

Jamieson (1968) examined members of the family Alluroididae. A single similarity matrix was subjected to three clustering strategies. Computations were done by desk computer, necessitating binary coding of data. For example, in order to code numbers and positioning of spermathecae, five questions requiring yes/no answers were required. More recent taxonometric programmes allow coding of non-metrical characters with much less distortion to 'fit' a coding format (for example Burr, 1968, 1970; Watson, Williams and Lance, 1967; Lance and Williams, 1967). Jamieson has also used methods similar to those described in the present paper to examine the usefulness of setal ratios as indicators of overall phenetic similarity at various taxonomic levels (Jamieson, 1972b, 1972d; Jamieson and Bradbury, 1972). In the groups he has studied, Jamieson has been able to show setal ratios to have the following qualities: (a) little intraspecific variation, any variation being mainly of an inter-populational nature; (b) reasonable homogeneity within genera, although not always good differentiation between genera of the same suprageneric group; and (c) strong similarities within and distinctness between suprageneric groups.

METHOD

Two tasks were planned: firstly, to examine groupings within an available plutelloid set, using as complete an attribute list as possible, and secondly to observe the effect of removing a small number (four) of 'highly rated' attributes from the study.

TABLE 1

O.T.U.'s Studied from the 'Plutelloid' Group

O.T.U. No.	Original name	Genus * (pre-revisional)	Grouping * (after Jamieson)
1	*Megascolides attenuatus* Spencer, 1892	Pu	S (<15)
2	*Plutellus candidus* Jackson, 1931	Pu	G (s)
3	*Megascolides eucalypti* Spencer, 1900	Pu	S
4	*Cryptodrilus fasciatus* Fletcher, 1889	Pu	F
5	*Cryptodrilus frenchi* Spencer, 1892	Pu	U
6	*Graliophilus georgei* Jamieson, 1971	—	G (g)
7	*Cryptodrilus hobartensis* Spencer, 1895	Pu	U
8	'*Megascolides incertus*' Spencer, 1892	Pu	S†
9	*Cryptodrilus insularis* Spencer, 1895	Pu	U
10	*Cryptodrilus intermedius* Spencer, 1892	Pu	S
11	*Cryptodrilus lucasi* Spencer, 1892	Pu	S
12	*Cryptodrilus macedonensis* Spencer, 1892	Pu	U
13	*Cryptodrilus manifestus* Fletcher, 1889	Pu	P
14	*Megascolides manni* Spencer, 1892	Pu	S
15	*Cryptodrilus minor* Spencer, 1892	Pu	S
16	*Cryptodrilus oxleyensis* Fletcher, 1889	Wa	H
17	*Megascolides roseus* Spencer, 1892	Pu	S (<24)
18	*Cryptodrilus semicinctus* Fletcher, 1890	Pu	U
19	*Megascolides steeli* Spencer, 1900	Pu	S (<14)
20	*Plutellus strelitzi* Michaelsen, 1907	Pu	G (s)
21	*Cryptodrilus tanjilensis* Spencer, 1892	Pu	U
22	*Notoscolex tasmanianus* Fletcher, 1888	Pu	U
23	*Megascolides tisdalli* Spencer, 1900	Pu	S
24	*Notoscolex tuberculatus* Fletcher, 1888	Pu	S
25	*Cryptodrilus ? unicus* Fletcher, 1889	Pu	F
26	*Cryptodrilus victoriae* Spencer, 1892	Pu	U
27	'*Cryptodrilus willsiensis*' Spencer, 1892	Pu	S‡
28	Mt Macedon B	—	—
29	*Plutellus adecus* Macnab and McKey-Fender, 1959	Pu (t)	A
30	*Plutellus blacki* Macnab and McKey-Fender, 1952	Pu (d)	A
31	*Plutellus davisi* Macnab and McKey-Fender, 1952	Pu (d)	A
32	*Plutellus fenderi executus* Macnab and McKey-Fender, 1958	Pu	A
33	*Plutellus fenderi fenderi* Macnab and McKey-Fender, 1958	Pu	A
34	*Plutellus heteroporus* Perrier, 1873	Pu	P
35	*Plutellus hyoiedes* Macnab and McKey-Fender, 1959b	Pu (t)	A
36	*Plutellus macnabi* McKey-Fender, 1957	Pu (A)	A
37	*Plutellus panulirus* Macnab and McKey-Fender, 1959a	Pu (d)	A
38	*Paraplutellus insularis* Jamieson, 1972	—	PP
39	*Simsia longwarriensis* Jamieson, 1972	—	S
40	*Woodwardiella ashworthi* Stephenson, 1931	Wa	H
41	*Cryptodrilus canaliculatus* Fletcher, 1889a	Wa	H
42	*Cryptodrilus cooraniensis* Spencer, 1900	Wa	H
43	*Woodwardiella dioecia* Stephenson, 1933	Wa	H
44	*Heteroporodrilus lamingtonensis* Jamieson, 1970	Wa	H
45	*Cryptodrilus mediterreus* Fletcher, 1889	Wa	H
46	*Cryptodrilus shephardi* Spencer, 1900	Wa	H
47	*Cryptodrilus tryoni* Fletcher, 1889b	Wa	H
48	*Plutellus varicystis* Jackson, 1931	Gu	G (g)
49	*Woodwardiella molaeleonis* Michaelson, 1907	Wa	W

Choice of Material

The material consisted mainly of the most recent literature descriptions of the species. In addition, for Australian material and *Plutellus heteroporus*, the author's nephridial descriptions were used, and for an unidentified specimen from Victoria all attributes were obtained by the author. It was found that older descriptions were usually imprecise and avoided definition of difficult systems such as nephridial and blood systems. More recent descriptions include a larger number of measured characteristics, and are based to some extent on an accepted descriptive format.

A list of attributes was drawn up for all plutelloid species described in three sets of literature:

(a) Australian material: Jamieson (1970, 1971a, 1972a, b, c and manuscripts), augmented where necessary and possible by Fletcher (1887, 1888, 1889), Spencer (1892, 1895, 1900), Jackson (1931), Sweet (1900) and the author's nephridial descriptions (Horan, 1971).

(b) American material: Macnab and McKey-Fender (1948, 1958, 1959 a, b), McKey-Fender (1957), and Gates (1941, 1962).

(c) Indian material: Gates (1945 a, b; 1961).

Thirty-seven morphological attributes, both external and internal, were selected as being cross-referrable in the Australian and American (Macnab and McKey-Fender) descriptions. As the Gates descriptions provided considerably less data, these were excluded from the study.

Forty-nine species for which sufficient codable information was available were chosen as O.T.U.'s (Operational Taxonomic Units). Table 1 gives the numbers used to identify O.T.U.'s, their original name, pre-revisional designation, and new grouping as given or proposed by Jamieson.

Coding of Attributes

The types of attributes described in the literature fell into three categories: two-state attribributes, which could be simply coded in binary terms; metrical attributes (measurements, counts, and standardized measurements); and attributes with more than two possible states. The terminology of Lance and Williams (1967) was adopted, the three types being designated as qualitative, quantitative, and multistate respectively. A list of thirty-six of these attributes is given in Table 2. A thirty-seventh attribute, 'prostate morphology' was withheld tentatively, because of its previous emphasis as a 'key' character

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* Abbreviations used in Table 1.

Pu: unrevised *Plutellus*; Wa: *Woodwardiella*; Pu (t): *Plutellus, toutellus* group; Pu (d): *Plutellus, davisi* group; Pu (A): *Plutellus, 'Argilophilus'* group.

A: proposed reinstated *Argilophilus*; F: reinstated *Fletcherodrilus*; G(g): *Graliophilus, georgei* group; G(s): *Graliophilus, strelitzi* group; H: *Heteroporodrilus*; P: *Plutellus*, restricted; PP: affinities with *Plutellus*; S: *Simsia*; U: unrevised; W: *Woodwardiella*, restricted; <: junior synonym of.

Names in quotation marks represent previously misidentified material.

† Now = *S. multituberculata* (Jamieson, 1972a).

‡ Subspecies of 10.

separating the genera *Plutellus* and *Woodwardiella*. It was planned to re-run using this character if it appeared that the study was prejudiced without it. Some of the multistate attributes used are non-exclusive (see Lance and Williams, 1967).

For the second task setal ratio attributes (quantitative attributes 1 to 4) were removed from consideration.

TABLE 2

ATTRIBUTES USED IN STUDY

QUALITATIVE

1.	Posterior setal arrangement	—	regular/irregular
2.	Shape of clitellum	—	annular/saddle-shaped
3.	Penial setae	—	presence/absence
4.	Position of last gizzard	—	segment V/segment VI
5.	Typhlosole	—	presence/absence
6.	Nephridial bladders	—	presence/absence
7.	Anterior tufted nephridia	—	presence/absence
8.	Testis sacs	—	presence/absence
9.	Arrangement of testes	—	metandric/holandric
10.	Supra-oesophageal vessel	—	single/double
11.	Position of last hearts	—	segment XII/segment XIII

QUANTITATIVE

1. Standardized setal ratio aa: circumference 100
2. Standardized setal ratio ab: circumference 100
3. Standardized setal ratio bc: circumference 100
4. Standardized setal ratio cd: circumference 100
5. Maximum number of segments occupied by clitellum
6. Number of segments containing spermathecal pores
7. Number of segments containing calciferous development
8. Number of latero-oesophageal hearts
9. Number of segments through which prostates extend
10. Ratio of spermathecal length: diverticulum length

MULTISTATE

1. Prostomial morphology—6 states:
   (i) prolobous; (ii) epilobous; (iii) tanylobous; (iv) proepilobous; (v) epitanylobous
2. Body length—3 states:
   (i) small (less than 65 mm); (ii) medium (65–200 mm); (iii) large (more than 200 mm)
3. Position of first dorsal pore—3 states:
   (i) anterior pre-clitellar (3/4 to 7/8); (ii) immediate preclitellar to clitellar (9/10 to 14/15); (iii) immediate post-clitellar (18/19 to 20/21)
4. Nephropore arrangement—6 states:
   (i) single series 'C' lines; (ii) single series mid 'CD'; (iii) single series 'D' lines; (iv) heteropore alternation; (v) other alternation; (vi) 'erratic' positioning
5. Clitellum position—4 states:
   (i) to segment XVIII; (ii) to segment XVII; (iii) to segment XVI; (iv) to segment XIX
6. Female pore position—3 states:
   (i) anterior median to 'A'; (ii) anterior to 'A'; (iii) anterior lateral to 'A'

7. Male pore position—5 states:
   (i) on 'A' (ii) in 'AB' (iii) on 'B' (iv) lateral to 'B' (v) median to 'A'
8. Spermathecal pore position—6 states:
   (i) median to 'A' (ii) on 'A' (iii) in 'AB' (iv) on 'B' (v) lateral to 'B' (vi) on 'C'
9. Morphology of calciferous glands—4 states:
   (i) no glandular development (ii) some swelling and vascularization (iii) extramural sessile glands (iv) extramural stalked glands
10. Position of calciferous glands—6 states:
   (i) to segment XIII (ii) to segment XIV (iii) to segment XV (iv) to segment XVI (v) to segment XVII (vi) to segment XII
11. Origin of intestine—8 states:
   (i) segment XIV (ii) segment XV (iii) segment XVI (iv) segment XVII (v) segment XVIII (vi) segment XIX (vii) segment XX (viii) segment XXIV
12. Position of nephridial tufts—6 states:
   (i) in segments II, III, IV (ii) in segments IV, V, VI (iii) in segments V, VI, VII (iv) in segments V, VI (v) single pair in II (vi) in segments II, III, IV, V
13. Position of seminal vesicles—7 states:
   (i) in segment XII (ii) in segments IX, X (iii) in segments IX, XII (iv) in segments X, XI (v) in segments XI, XII (vi) in segments IX, X, XI, XII (vii) in segments IX, XI, XII
14. Morphology of seminal vesicles—2 states:
   (i) racemose (ii) tubular
15. Morphology of spermathecal diverticulum—6 states:
   (i) no diverticulum (ii) diverticulum intramural (iii) 1 uniloculate diverticulum (iv) 2 uniloculate diverticuli (v) 1 multiloculate diverticulum (vi) 2 multi.oculate diverticuli

PROGRAMMES

The programmes were chosen by Dr W. T. Williams, of C.S.I.R.O. Division of Tropical Pastures, Brisbane, from mixed data classificatory programmes designed by himself and Dr G. N. Lance, and available on the Control Data 3600 computer in Canberra. Two programmes were selected, and both were used for each task. These were the MULTBET programme, sorting by an information statistic strategy (Lance and Williams, 1967) and the MULTCLAS programme, as described by Lance and Williams (1967), but sorting by the increment in sum of squares strategy of Burr (1970). Both programmes employ agglomerative methods to supply a dendrogram; that is they create a hierarchical classification by a process of successive fusions of elements, based on some sort of difference measurement between the elements. In the information statistic strategy this difference is expressed as the information gain associated with the fusion; in the Burr strategy the elements are treated as points in a Euclidean space, and fusion occurs between pairs or clusters of elements whose combination provides the lowest increment in the sum of the squared Euclidean distances between the points and their centroid.

A second portrayal of the relationships obtained by the programme was given in each case by a basic ordination process, using the principal coordinates analysis of Gower (1966).

The print-out from each ordination consisted of coordinates 1 to 7. Of these, the first three coordinates were plotted.

Lance and Williams (1967) recommend the information statistic MULTBET strategy as the most suitable programme available at that time. The Burr strategy MULTCLAS programme has been developed since then, and compares favourably with the MULTBET (Williams, pers. com.). In the MULTBET programme, quantitative characters are treated as 'ordered' (i.e. ranked) multistates; in the Euclidean system, all characters are treated as metrical. The Burr strategy tends to be more accurate in its treatment of quantitative characters than does the information statistic strategy.

The MULTBET strategy has recently been found to show the phenomenon of 'group size dependence'—comparisons between groups are affected by a difference in size of the groups (Williams, Clifford and Lance, 1971). This effect increases with the square of the number of elements in a group, and thus will not be expected equally in all classifications obtained by this method. However, if a dendrogram contains groups of extremely unequal size at the same level, groupings at higher levels will be biased to some extent by group size dependence.

Number and Nature of Attributes

The number of attributes used in tasks 1 and 2 (thirty-six) may appear small. Sims (1966, 1969) uses forty-three, Jamieson (1968) sixty-nine and Lee (1970) forty-six attributes. Two important differences between these and the present study stem from (a) the nature of the O.T.U.'s used, and (b) (in Jamieson's work) the nature of the coding.

(a) O.T.U.'s: In Sims' (1966, 1969) paper, the O.T.U.'s are species, but the emphasis is not on their singularly 'species' nature; each species (in one case two species) is used to represent its higher taxon. Jamieson also uses species as O.T.U.'s, but as well as members of the group under investigation he uses as 'calibrators' species from other families. In both cases, gross differences can be expected in attributes which do not vary at lower taxonomic levels.
Sims's work has been criticised by Lee on the grounds that the O.T.U.'s, though used as generic representatives, are actually no more than species, and thus the attributes used are predominately those of species. The suggestion is that a character-list from such an O.T.U. set would consist of finely differing species-characters, bolstered by grossly differing higher taxon-characters. Such a character-list could only be valid when large numbers of representative species were used for each genus chosen. This is the case in Lee's work, where 170 of the 178 New Zealand species of Megascolecids were used as O.T.U.'s.

(b) Coding: As noted above, in Jamieson's analysis, some attributes which in the present paper are treated as a single multistate were broken into a number of two-state attributes.

The group chosen for study was homogeneous in regard to some attributes. It is considered that the attributes coded for the computations give a reasonable coverage of the varying morphological features, with some notable exceptions. In particular a larger number of blood system characteristics would have been preferred. The difficulties of cross

reference in character descriptions for the blood system can be attributed to the lack of a definitive work on this system, and also to the usually small series of specimens available for examination to revisers—the blood system is delicate and difficult to determine in preserved specimens.

RESULTS

Programme with all Attributes

Dendrograms: In the information statistic (Fig. 1), the first major groupings are of approximately equal status and size (except for one two-membered group). These can be summarized as follows:

(1) the unresolved Tasmanian *Plutellus tasmanianus*, the unresolved *P. tisdalli*, the two-membered *Plutellus* sens. strict., two *Heteroporodrilus*
(2) the remaining *Heteroporodrilus*
(3) all proposed reinstated *Argilophilus*
(4) seven *Simsia*, three *Graliophilus*, the unresolved *P. semicinctus*
(5) the remaining *Simsia* species
(6) reinstated *Fletcherodrilus*
(7) unresolved Victorian and Tasmanian *Plutellus*, one *Graliophilus*, the single included *Woodwardiella*

The next fusion combines each of the pairs 1-2, 4-5 and 6-7. The final fusion is between group 1-2 and the group formed of the remaining O.T.U.'s.

In the Euclidean dendrogram (Fig. 2) the first major groups vary more in size, but are approximately equal in status. These are as follows:

(1) reinstated *Fletcherodrilus*
(2) a single-membered group, the unresolved *P. tasmanianus*
(3) a group of unresolved *Plutellus*, constituting all except *P. macedonensis* of the unresolved *Plutellus* in group 7 of the information statistic programme
(4) *Plutellus* sens. strict., the unresolved *P. tisdalli*, *Paraplutellus insularis*—that is, part of group 1 in the information statistic strategy
(5) all *Heteroporodrilus*
(6) proposed reinstated *Argilophilus*
(7) five *Simsia* members
(8) *Graliophilus*, *strelitzi* group
(9) the remaining *Simsias*, two *Graliophilus* (*georgei* group)

In the succeeding fusions, groups 7-8-9, groups 4-5, and groups 1-2-3 become united, to form clusters close in constitution to clusters 4-5, 1-2, and 6-7 respectively in the information statistic dendrogram. Finally two large groups are formed, the one containing *Fletcherodrilus*, *Heteroporodrilus*, *Plutellus* sens. strict., *Paraplutellus*, and all unresolved *Plutellus* except *Plutellus macedonensis*, the other containing *Argilophilus*, *Simsia*, *Graliophilus*, *Woodwardiella molaeleonis*, and *P. macedonensis*.

Ordinations: The GOWER ordinations, using the first three coordinates, for the information statistic programme are given in Fig. 3.

The strongest clustering occurs in the cases (a) entire proposed reinstated *Argilophilus* and (b) entire *Heteroporodrilus*, plus *Plutellus* sens. strict and *Paraplutellus insularis*. Within cluster (b) *Plutellus* and *Paraplutellus* become distinguished from the rest of the group in the third vector. O.T.U.'s 4 and 2 (*Fletcherodrilus fasciatus* and *Graliophilus candidus*) occur as separate entities. The remaining material forms one diffuse group in which, however, some unplaced *Plutellus*, O.T.U.'s 7, 9, 5, 21, 25, and 28 form a loose

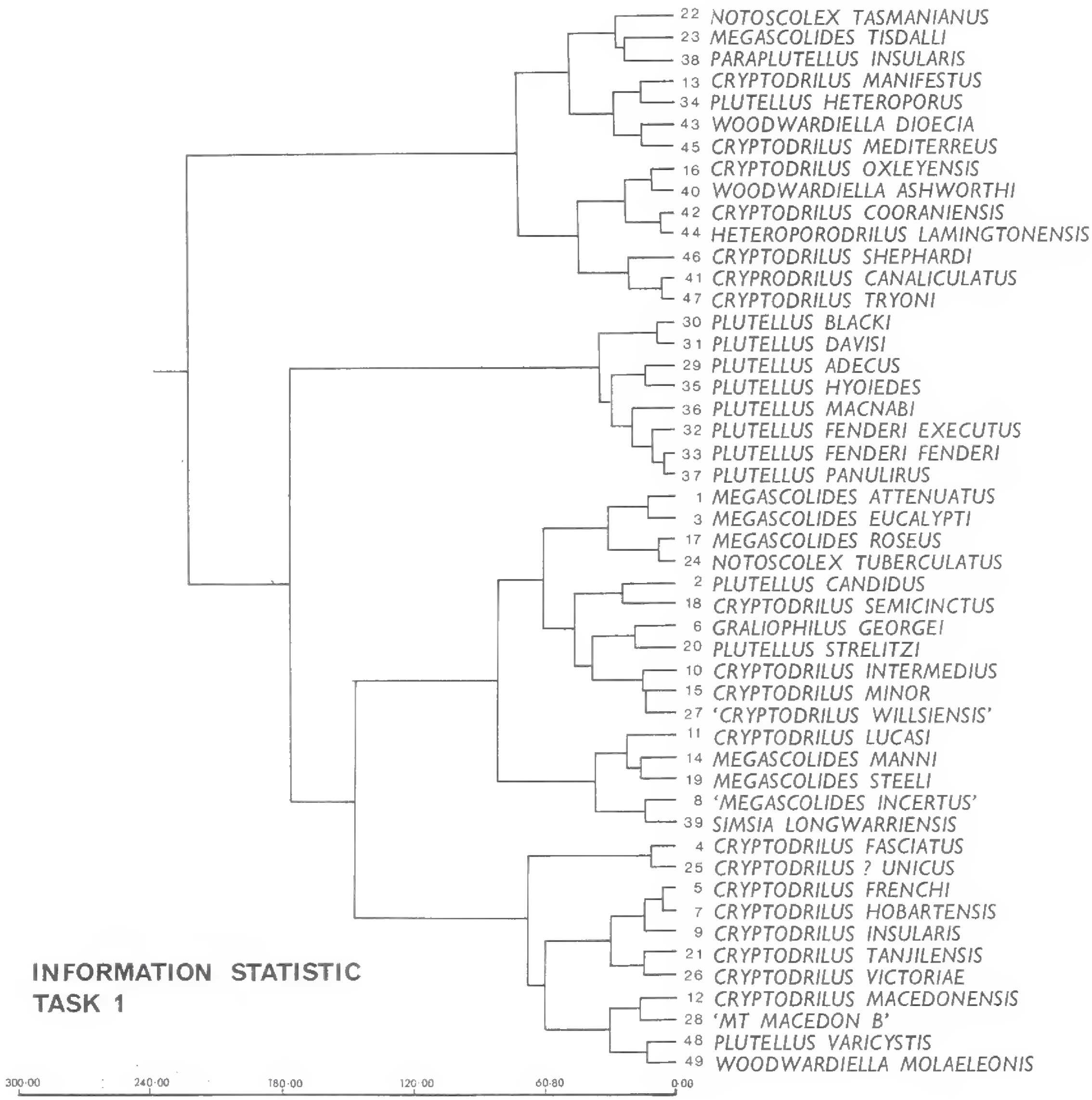

FIG. 1: Dendrogram of relationships among the 49 O.T.U.'s as determined by the information statistic strategy using 36 attributes.

'group' in that they do not mingle with the *Simsia* material: the remaining O.T.U.'s are scattered between these two loose groups.

The ordinations for the Euclidean programme are shown in Fig. 4. Here again distinct clusters are formed of the *Argilophilus* and *Heteroporodrilus-Plutellus* sens. strict.-*Paraplutellus* material. O.T.U.'s 2, 4 and 23 form a loose group in the principle coordinates ordination, with 2 (*Graliophilus candidus*) separating from the cluster on the third co-

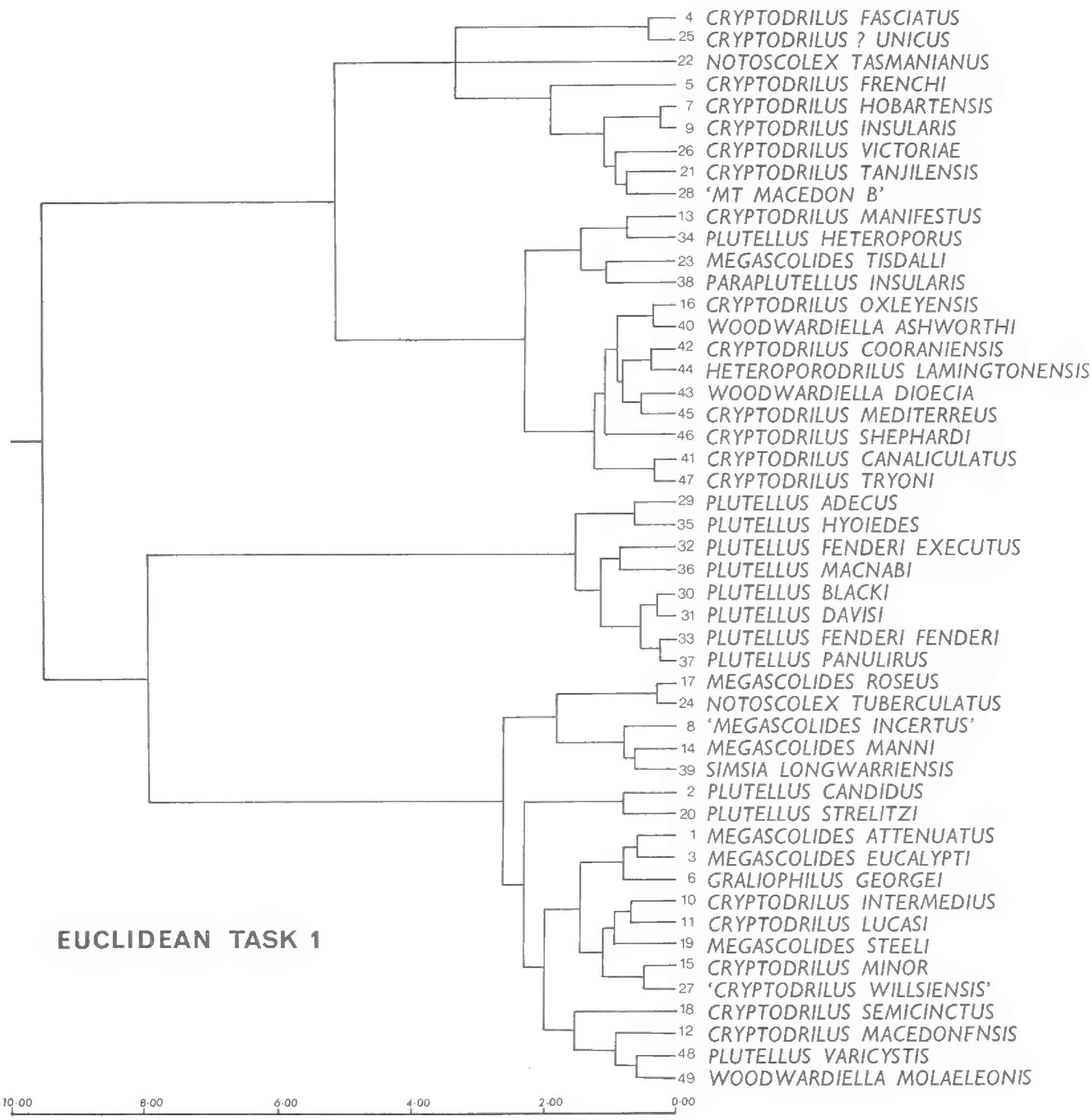

FIG. 2: Dendrogram of relationships among the 49 O.T.U.'s as determined by the Euclidean (increment in sum of squares) strategy, using 36 attributes.

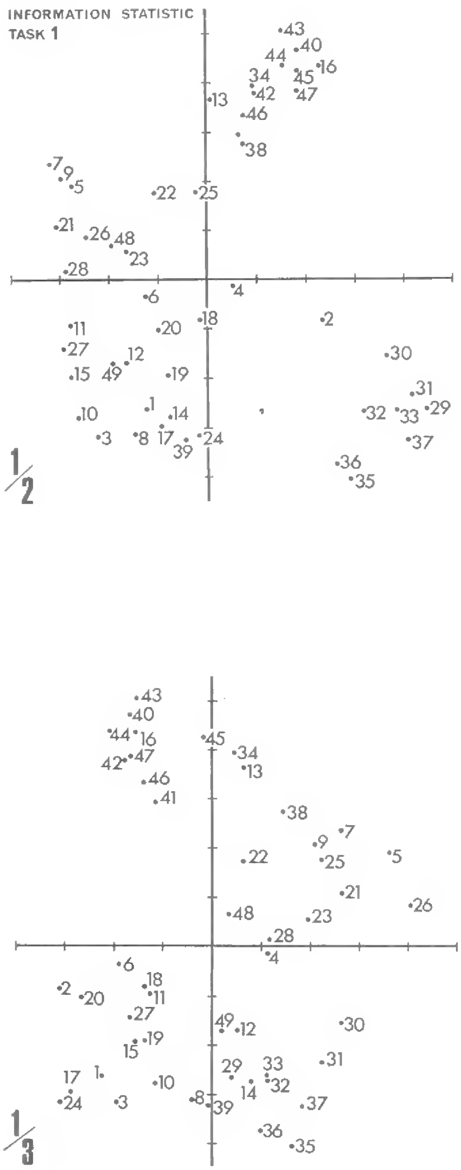

FIG. 3: GOWER ordination along three axes for the information statistic programme using 36 attributes. Numbers represent O.T.U.'s, as in text.

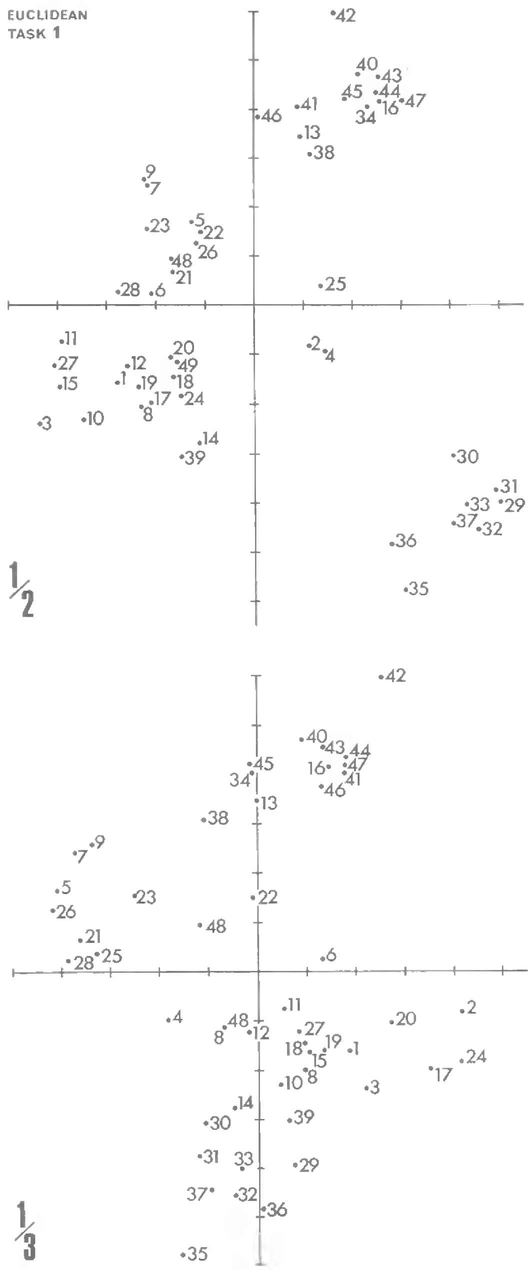

FIG. 4: GOWER ordination along three axes for the Euclidean (increment in sum of squares) programme using 36 attributes. Numbers represent O.T.U.'s, as in text.

ordinate. The *Simsia* material, plus O.T.U.'s 12, 18, 20, and 49 (*Plutellus macedonensis*, *P. semicinctus*, *Graliophilus strelitzi*, and *Woodwardiella molaeleonis*) form a loose cluster. The remaining material forms another loose cluster, close to this, with O.T.U.'s 7, 9, 5, 21 and 28 clustering on the third axis.

Programme Omitting Setal Ratios

The dendrograms from the programmes which excluded setal ratio attributes are given in Fig. 5 (information statistic) and Fig. 6 (Euclidean).

At the numbered grouping levels, the structure of the Euclidean dendrogram remains almost unchanged. The single-membered group 2 of task 1 joins group 5, and some rearrangements occur in groups 8 and 9. Membership of the two large groups is thus the same as in task 1, although the fusions forming the groups occur earlier in task 2 dendrograms.

In the information statistic, although the groupings at the numbered level remain little changed, the old group 6-7, minus O.T.U.'s 12, 48 and 49, is transferred from its combination with the *Simsia-Graliophilus-Argilophilus* group to join the *Heteroporodrilus-Plutellus* sens. strict.-*Paraplutellus* group. The dendrogram then agrees with the Euclidean dendrogram for both tasks. In the ordinations (Figs. 7, 8) no obvious alterations of the groupings in Figs. 3 and 4 are detectable.

Discussion of Results

The strategies used provided some compact groupings essentially in harmony with groupings proposed by Jamieson. In interpreting dendrograms and also vector diagrams, consideration should be made of the following points: (a) visual analysis of graphic results can be biased to some extent by the size of the group; (b) small groups, in particular one-membered groups, will tend to be accommodated within adjacent groups, and thus lose identity; (c) because of the phenomenon of group-size dependence, particularly in the MULTBET programme (Williams, Clifford, and Lance, 1971) larger groups will tend to be better defined than smaller groups.

Programme with all Attributes: The 'neatest' grouping is that of the North American O.T.U.'s. All American species included in the study are described by Macnab and McKey-Fender (between 1948 and 1959). Their work is thorough, usually based on large population samples and detailed examination of variation. In all sets of results for the present study, the North American species form a compact group, well separated from other groups, and with affinities within the group agreeing with those proposed by Macnab and McKey-Fender. Jamieson (1971c) suggests that reinstatement of Eisen's *Argilophilus* for these and other western North American *Plutellus* is justified. This move has not been proposed by Macnab and McKey-Fender, who do however regard this group as distinct from Perrier's *Plutellus*.

The results agree with the predicted affinities (Jamieson, 1971c, 1972a) of a *Plutellus* sens. strict.-*Paraplutellus-Heteroporodrilus* group, although some separation of *Plutellus* and *Paraplutellus* from *Heteroporodrilus* is visible, particularly in the ordinations. This separation would be enhanced by the inclusion of prostate morphology and a further

nephridial attribute in the attribute list. (In *Plutellus* sens. strict. and *Paraplutellus* alternation of nephropores between setal lines b and d commences on segment V or VI; in *Heteroporodrilus* this commences on segment X). Jamieson (pers. com.) suggests that separation of these O.T.U.'s into three genera is justified by the extra information so conveyed.

The members of Jamieson's newly-named genus *Simsia* (1972a, 1972b) do group together, but the grouping is not exclusive. This is mainly due to the enigmatic arrangement

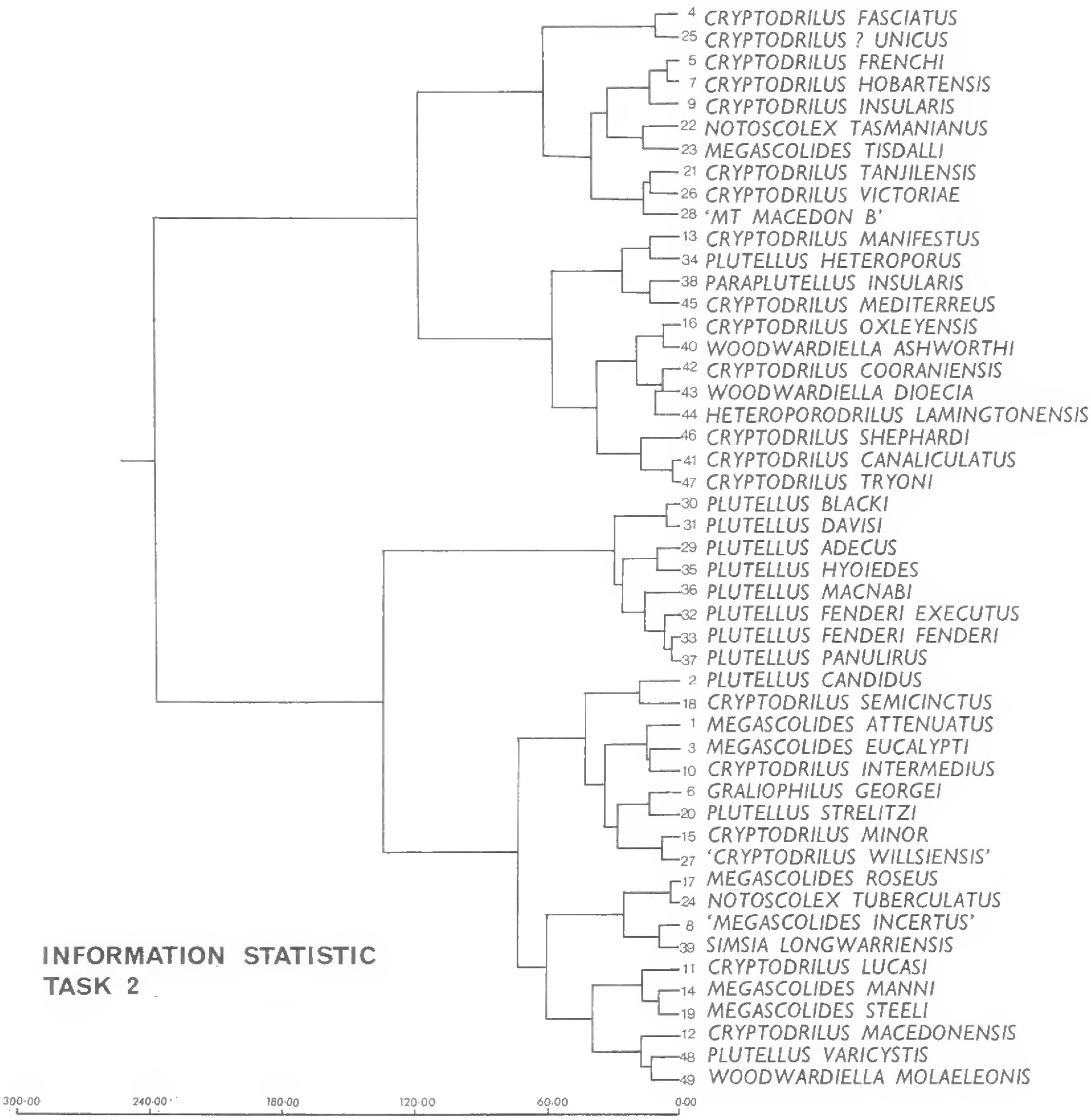

FIG. 5: Dendrogram of the relationships among the 49 O.T.U.'s as determined by the information statistic strategy, omitting the four setal ratio attributes.

of the Western Australian material, which is interspersed amongst the *Simsia* placings. As predicted by Jamieson (1970), *Woodwardiella molaeleonis* is well separated from the *Heteroporodrilus* group, formerly all included in *Woodwardiella*. *W. molaeleonis* pairs in both dendrograms with *Plutellus* (now *Graliophilus* Jamieson) *varicystis*. As only four members of the new genus *Graliophilus* were included in the study, their erratic placement could possibly be due to poor relationship with each other, and thus their inclusion in the group to which they are most similar (apparently the *Simsia* group). This could be tested

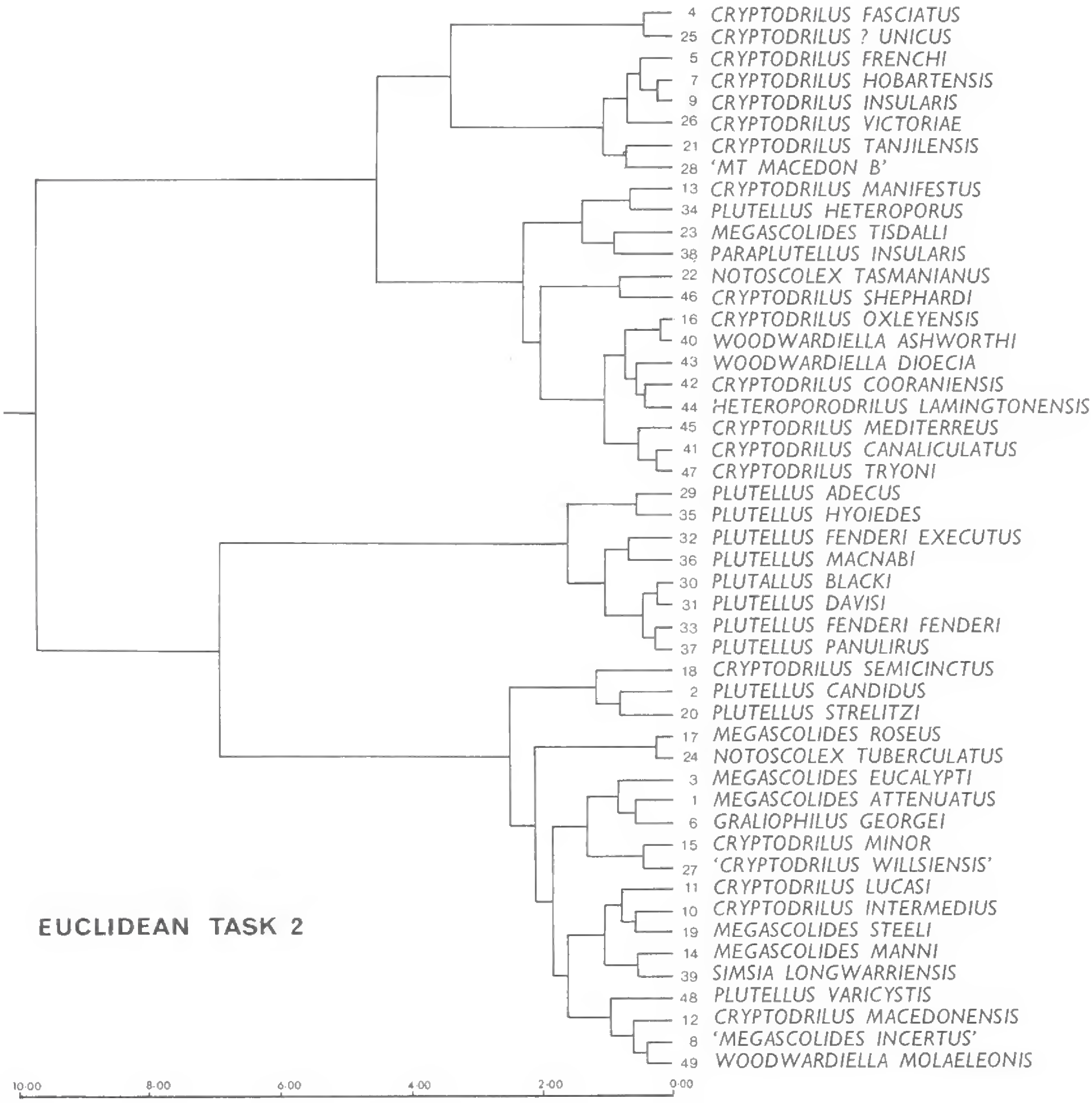

FIG. 6: Dendogram of the relationship among the 49 O.T.U.'s as determined by the Euclidean (increment in sum of squares) Strategy, omitting the four setal ratio attributes.

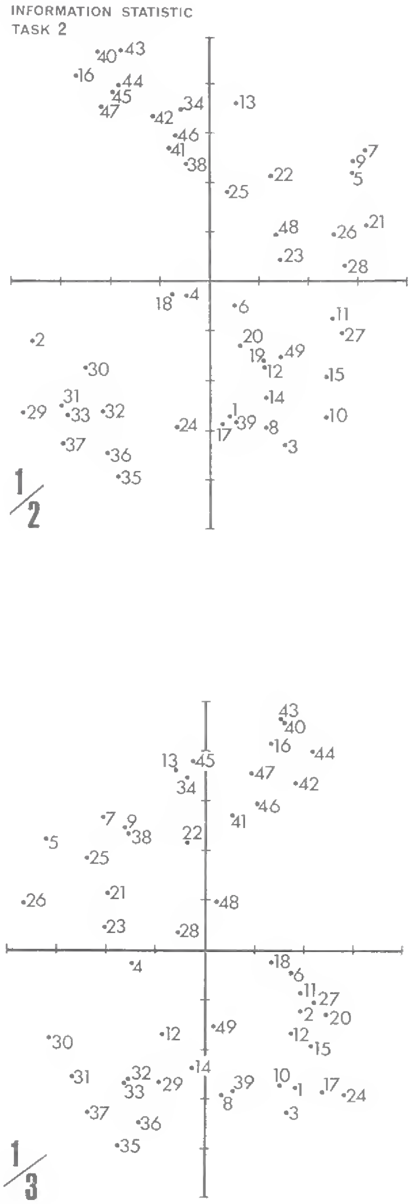

FIG. 7: GOWER ordination along three axes for the information statistic programme omitting the four setal ratio attributes. Numbers represent O.T.U.'s, as in text.

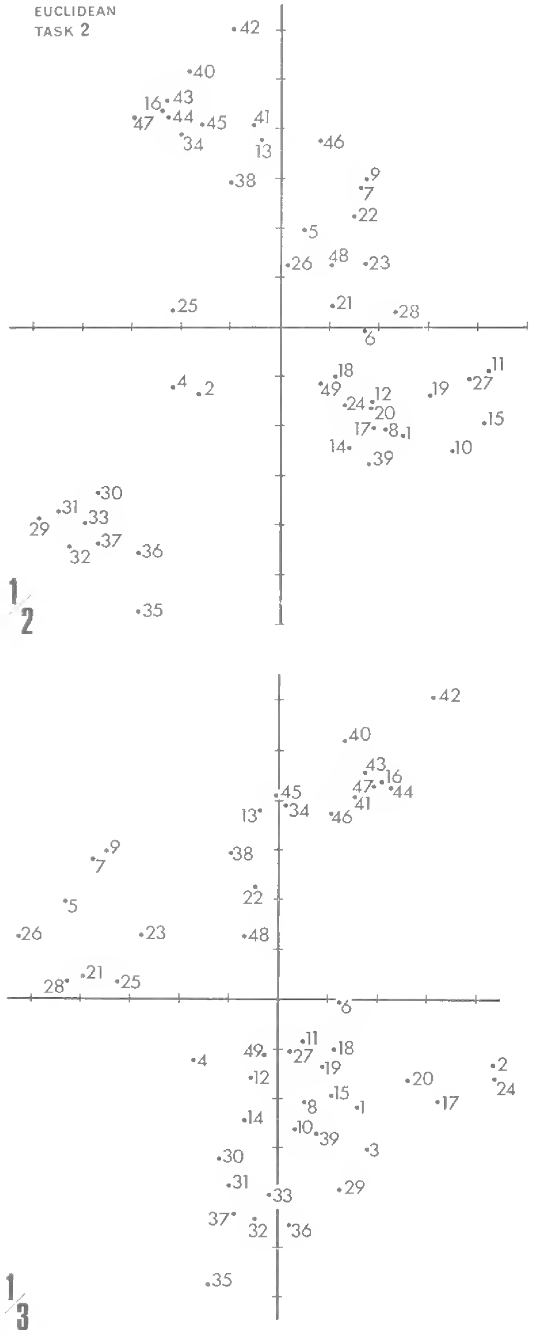

FIG. 8: GOWER ordination along three axes for the Euclidean (increment in sum of squares) programme omitting the four setal ratio attributes. Numbers represent O.T.U.'s, as in text.

by examination of a more exhaustive species list, which could exclude those O.T.U.'s with which *Graliophilus* and *Simsia* formed no fusions.

The two-membered reinstated *Fletcherodrilus* Michaelsen (Jamieson, 1970) remains as a reasonably well-isolated pair in both the dendrograms and the ordinations.

Placement of some of the unresolved *Plutellus* is erratic, but on the basis of the reasonable agreement obtained for most of the previously proposed groupings, it is suggested that a further group, comprising *Plutellus frenchi*, *Plutellus hobartensis*, *Plutellus insularis*, *Plutellus tanjilensis* and *Plutellus victoriae* (and the Mt Macedon specimen, which must be ignored until further specimens are found) could possibly be given status as a genus.

PROGRAMME OMITTING SETAL RATIOS: Removal of the four quantitative setal ratio attributes had very little effect on the groupings at the 'probably generic' level, and only a slight effect at the higher fusion levels. This tends to support the suggestion (Jamieson, 1972b, 1972d) that these attributes distinguish well between suprageneric groupings but less well between genera. As the intensity of clustering at the 'probably generic' level is little changed by their removal, it seems unlikely that in this case setal ratios are acting as a summary of overall phenetic similarity at this level; however, a separate programme, using setal ratios only, would be required to test this. It is possible that in this case they have a 'noise' function only.

DISCUSSION

With very few exceptions, species criteria in oligochaete descriptions are entirely morphological, and as is the case with many of the species of the plutelloid group, all that is known of a species is known from a few preserved specimens. Moss and Webster (1969, p. 423) point out that the same is true for the parasitic Nematoda:

> The biological species concept has, at present, little applicability to the field of parasitic nematology, an area in which species must be recognized almost entirely on the basis of anatomical evidence.

When this factor is coupled with the paucity of palaeontological evidence, it is clear that classifications will usually involve either interpretation of the evolutionary relevance of present structures, or consideration of similarities based on a range of characteristics.

The first approach was tried in the Oligochaeta, and the resulting classification perpetuated for fifty years before its highly unsatisfactory and artificial nature was challenged (see discussion in Lee, 1959, p. 31). Since Gates (1937), most oligochaete workers have favoured the second approach, sometimes referred to as 'intuitive'. It would seem obvious that computer methods provide the oligochaete taxonomist with more efficient, operationally definable means of carrying out the same task. The present work is considered to provide an example of this.

Coding difficulties experienced in the present work indicate that, if numerical techniques are to be used, descriptive formats will in future require standardization with this in mind. Ideally, before the phenetic approach is applied on a large scale to generic and super-generic levels in the Oligochaetes, it should be applied to questions of infraspecific variation and species limits.

ACKNOWLEDGEMENTS

I am indebted to Dr B. G. M. Jamieson, Zoology Department, University of Queensland, for advice throughout the work, for allowing his descriptions, while still in manuscript form, to be used to compile the attribute sets, and for reading the manuscript.

I am also indebted to Dr W. T. Williams, of C.S.I.R.O. Division of Tropical Pastures, without whom this work (and, I suspect, countless other taxonometric projects) could not have been done, and to his assistant Mrs Kathy Stephens.

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SOME UPPER CHEEK TEETH IN *PROPLEOPUS OSCILLANS* (DE VIS)

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Queensland Museum

ABSTRACT

A recently collected maxillary specimen of *Propleopus oscillans* (De Vis) containing P^3–M^2 is described. This specimen, from the Pleistocene fluviatile deposits of the Darling Downs, Queensland, provides the first evidence of the upper dentition in this interesting potoroine macropodid. It reinforces previous ideas on the relationships of this species to other potoroines.

The fossil macropodid, *Propleopus oscillans* (De Vis) presents numerous features which have interested research workers since its original description by De Vis (1888). Recent work by Woods (1960) and Ride (1964) has been directed towards defining the morphology and elucidating the relationships of this, the largest known member of the subfamily Potoroinae. Results have, however, been limited by the quantity and nature of the referred material available. At the time of Woods's (1960) redescription, only three specimens were known in collections and all were mandibular.

It was thus of particular interest to receive recently a maxillary specimen containing the first three of the permanent cheek teeth, collected from the Pleistocene fluviatile deposits of the eastern Darling Downs, southeastern Queensland. In view of the interest expressed in *Propleopus* it was felt appropriate to describe the specimen and to re-examine the conclusions on the relationships of the genus based on the comparisons of mandibular characters in the light of the new evidence available.

The author wishes to express his appreciation to Mrs E. Ward, who discovered the specimen and who donated it to the collections of the Queensland Museum.

Propleopus oscillans (De Vis, 1888)

(Plate 8, figs. 1–4)

Triclis oscillans De Vis, 1888, p. 8.
Propleopus oscillans (De Vis): Longman, 1924, p. 20.
Propleopus oscillans (De Vis): Woods, 1960, pp. 199–212.

Additional Material: F6675, partial left maxilla with P^3–M^2, adult, Pleistocene fluviatile deposits at Cattle Creek, north of Dalby, eastern Darling Downs, at M.R. 436648 Chinchilla 1 : 250000 sheet, southeastern Queensland.

Measurements (mm): P^3 length 15·2, maximum width 10·8; M^1 length 10·5, width 9·7 anteriorly, 9·3 posteriorly; M^2 length 11·1, width 10·3 anteriorly, 9·1 posteriorly.

SUPPLEMENTARY DESCRIPTION: Maxilla known only in fragmentary state. Inferior process of anterior zygoma root broken, but sufficient remains to indicate process positioned posterior to M^1; palate perforate, with well defined posterior palatine foramen present; anterior extremity of foramen extends to level of M^1; palate relatively narrow.

P^3 apparently bi-rooted, with posterior root very large, obliquely positioned; permanent premolar larger than molars, suboval at base of crown; crest trenchant, oblique, set at angle of approximately 20° with molar axis, slightly convex labially; crown high, with enamel considerably higher anteriorly than posteriorly, and with crest slightly convex ventrally in lateral view. Crest transected by seven sets of strong ridges labially and lingually with development of well defined cuspules along crest; ridges decrease in strength posteriorly, strongly convexly curved anteriorly between crest and base of crown but becoming more sinuous posteriorly, occasionally confluent basally; small cuspule developed posterolabially. Base of crown tumid labially and lingually.

$M^1 < M^2$; molar row apparently straight. Molars brachyodont, subrectangular in basal outline with protoloph broader than metaloph. Anterior cingulum low, relatively broad, short, extending labially and lingually beyond major anteriorly directed ridges from anterior cusps. Strong, sharply defined ridge curves anterolingually from paracone to anterior cingulum while stronger, broader ridge ascends anterolabially to cingulum from protocone; loph between anterior cusps narrow, slightly convex anteriorly. Posterior ridge from paracone strong, sharply defined, curving lingually well within labial limit of median valley to unite with similarly curving anterior ridge from metacone. Slight additional antero-posterior ridge present at limit of valley in M^2. Moderately broad, strong ridge ascends posterolabially from protocone to unite with similar anterior ridge from hypocone above median valley; accessory ridge curves and ascends anterolingually from below hypocone towards base of protocone delimiting lingual extent of median valley. Valley broadly U-shaped in labial moiety, sharply V-shaped lingually. Loph between posterior cusps narrow, slightly convex anteriorly. Posterior ridge from metacone ascends posteriorly towards base of crown and unites with stronger, broader ridge ascending, flaring and curving posterolabially from hypocone. Posterior fossette well developed. Base of crown bulbous.

DISCUSSION: *Propleopus oscillans* is currently recorded only from Pleistocene deposits in the Darling Downs area, Queensland and from the Wellington Caves, New South Wales (Woods, 1960). However, an isolated lower molar tooth from the late Pliocene Hamilton Fauna at Grange Burn, Victoria has been compared with *Propleopus* by Ride (1964) and by Turnbull and Lundelius (1970), but both authorities, while accepting potoroine affinities for the specimen, prefer to leave its identity at a general level. Bartholomai (in press) has indicated the existence of an additional, possibly Pliocene mandible of *Propleopus* from New South Wales (Mahoney, pers. com.).

In comparing *Propleopus* with living potoroines, Woods (1960) concluded that the mandibular remains were structurally closest to those in *Hypsiprymnodon moschatus* and in species of *Bettongia*. The dentition in *Hypsiprymnodon* has been adequately described in Woods (1960) and in Ride (1961). Certain characters in the lower dentition in *Propleopus* were found to be more closely similar to *H. moschatus*, while in other respects the comparison favoured *Bettongia* or proved intermediate between that in *H. moschatus* and

B. penicillata. The pattern of wear in the lower incisors was shown to be unique to *Propleopus* among the Potoroinae (Woods, 1960). Disregarding considerations of size, Woods (1960) further concluded that gradation between the three genera was not uniform and that their distinctness as identifiable taxa must be maintained.

Comparison of the maxillary remains shows that the posterior palatine foramen, although large in *P. oscillans*, does not extend anteriorly as far as in *H. moschatus* and is more like the condition seen in species of *Bettongia*. On the other hand, the inferior orbital foramen must have opened in advance of P^3, low on the lateral surface of the maxilla, similar to the condition in *Hypsiprymnodon*. That in *Bettongia* is normally developed above P^3 high on the lateral maxillary surface.

The molar tooth row appears to be slightly divergent anteriorly in occlusal view relative to the sagittal plane and to be nearly straight in the molars preserved. The condition is more like that in *Hypsiprymnodon* than that in *Bettongia* where the tooth row is somewhat arcuate. Deflection of the crest of P^3 is, as in lower cheek teeth, slightly less pronounced than in *H. moschatus*.

Structurally the P^3 in *Propleopus* is much more like that in *H. moschatus* than that in *Bettongia*. The crown is relatively much lower posteriorly, however, and the transecting ridges are more arcuate in their development. The molars are less ovate in basal outline than in *Hypsiprymnodon* and have much better developed anterior cingula, lophs and accessory ridging, and in these latter features appear more like *Bettongia*.

The morphology of the maxillary specimen of *P. oscillans* thus supports Woods's (1960) conclusion that the species stands closest to *Hypsiprymnodon* among the living potoroines. Sufficient distinctions are present to suggest that no direct line of relationship can be inferred and that the separation of the taxon at the generic level is justified.

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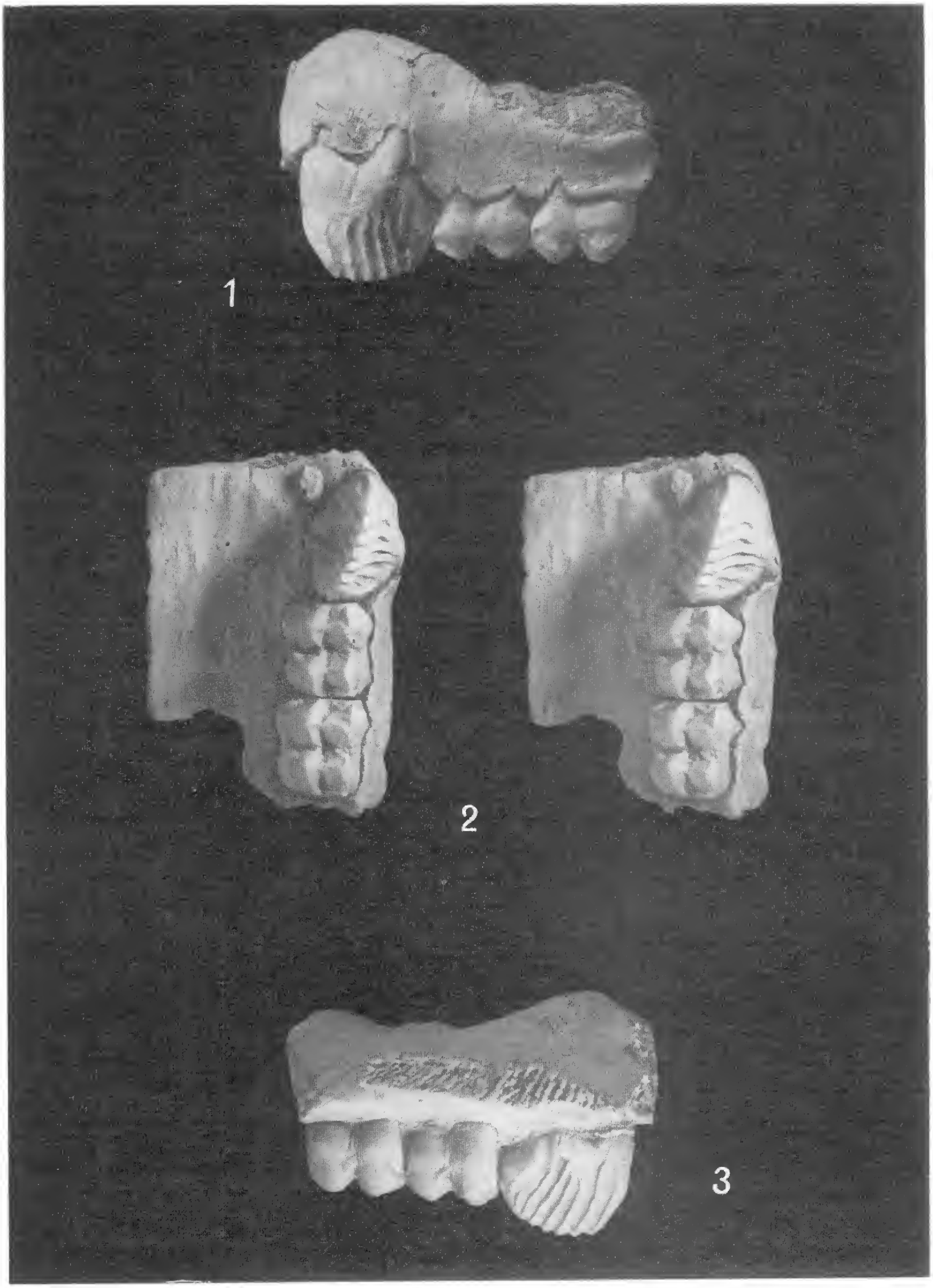
Plate 8

Fig. 1: Labial view of F6675, *Propleopus oscillans* (De Vis), $\times 1$.

Fig. 2: Stereopair of F6675, *Propleopus oscillans* (De Vis), occlusal view, $\times 1$.

Fig. 3: Lingual view of F6675, *Propleopus oscillans* (De Vis), $\times 1$.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Mem. Qd Mus. (1972) **16**(2): 215–221.

ABORIGINAL ROCK ENGRAVINGS NEAR ROCKY SCRUB CREEK, JUNCTION VIEW, SOUTHEAST QUEENSLAND: TRYON'S PIGEON CREEK SITE RE-RECORDED

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Queensland Museum

ABSTRACT

Rock engravings near Rocky Scrub Creek southeast Queensland were re-recorded. Linear, non-figurative in style, they are marginally related to other sites east of the Great Dividing Range between 24° and 30° south.

Rock engravings are found in a small sandstone rock shelter situated above the right bank of Rocky Scrub Creek, a non-perennial watercourse running into Black Duck Creek, part of the Lockyer Creek-Brisbane River drainage system. The site is located approximately 97 km (60 miles) south-southwest of Brisbane at the base of the Great Dividing Range (Fig. 1). The map reference is Australia 1 : 63,600, *Liverpool Range*, 254 487. At this point, there is a relatively easy access route over the main range to Hirstglen on the Darling Downs. This track was still frequented by local aboriginal groups in the early 1840's, during the initial period of European settlement in the Gatton-Grantham district.

Early in 1884 Henry Tryon, at that time Assistant Curator of the Queensland Museum, visited the site on what was then referred to as Pigeon Creek. His graphic record at a scale of 1 inch to 1 foot and accompanying paper were published by the newly constituted Royal Society of Queensland in the same year (Tryon, 1884).

In addition to this early record of aboriginal parietal art, Tryon apparently performed what was perhaps the first archaeological excavation in Queensland. He removed enough spoil '. . . of sufficient quantity to fill a large cart,' (Tryon, 1884, p. 46). Present ground level which is 30 cm lower than that described in 1884 appears to confirm this statement. He recovered a quantity of material comprising freshwater mollusc and snail shells, reptile and marsupial bones, and stone implements eight of which were illustrated (Tryon, 1884, pl. 13). Unfortunately none of this excavated material has survived; there is no record of it ever having been incorporated into the Queensland Museum's anthropological collections.

At some date before 1964 (Colliver, 1970, p. 9), the engravings were covered over with white paint by some misguided person interested in their preservation; thus effectively obscuring the actual arrangement of the art and misrepresenting individual designs. Accordingly it was decided that the paint should be removed by specialists from the Queensland Museum. This task was carried out under the supervision of the late Malcolm

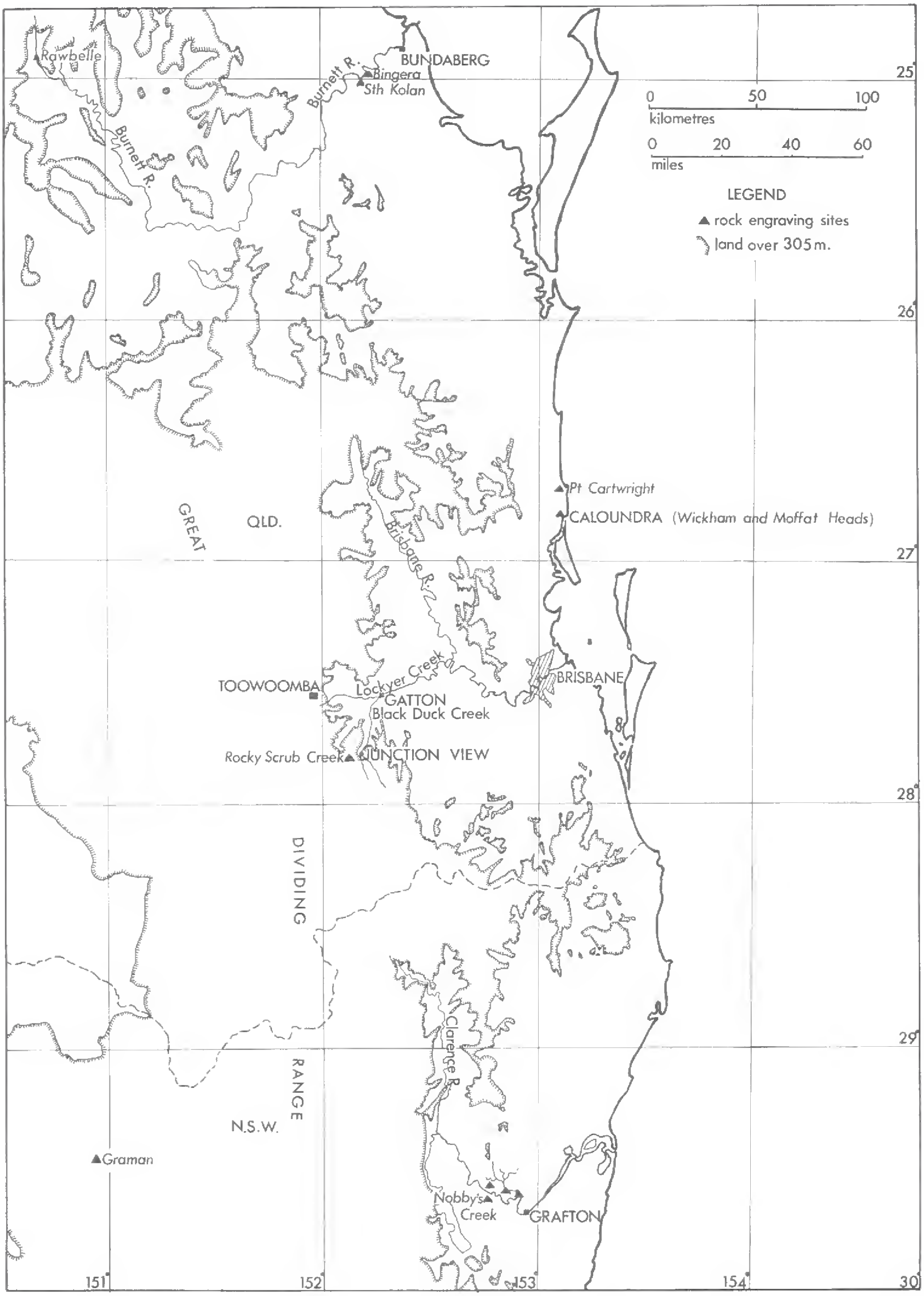

FIG. 1: Map of southeast Queensland and northern New South Wales showing rock engraving sites.

McAnna in October 1969. On successful completion of this process, it was noted that Tryon's record could only be termed a freehand sketch, albeit to scale, and that his record differed in a number of matters of detail from the original.

Recording was then undertaken, initially with a portable grid and scale drawings, and later by tracing with a felt pen on clear polythene sheets. A photographic survey using colour transparencies and monochrome film taken with oblique flash was also completed. All the above methods were used in the compilation of the final graphic record presented here (Fig. 4).

References to Tryon's paper have been included in a number of surveys and reports concerned with Australian aboriginal parietal art (Davidson, 1936; Elkin, 1949; McBryde, 1964; McCarthy, 1967; Colliver, 1970). Details from his record were reproduced by two of these authors, but in one case the selection was published upside down (Davidson, 1936, fig. 6) and in the other, one detail appears sideways (Elkin, 1949, fig. 3e top). Publication of a more accurate record was therefore thought desirable.

DESCRIPTION

The Site

Seven slabs of thickly bedded, medium grained sub-labile to siliceous sandstone of the Upper Marburg beds (typical of the Mount Sylvia-Lockyer Valley region) combine to form a rock shelter with a sheer vertical face suitable for decoration. The texture of the sandstone renders it easy to abrade or puncture.

The site faces northwest and is situated 10 metres distant and 4 metres above the level of the creek bed (Fig. 2). Bone fragments, quartzite, chert and common opal waste flakes, and other remains from the habitation deposit are still strewn over the steep slope. It is probable that Tryon's excavation did not plumb the depths of the site. However, evidence of recent illegal excavations leaves little chance of finding much undisturbed deposit. The total length of the sandstone structure is 14·75 metres. The collapse of an immense sandstone slab has reduced the dimensions of the art and habitation area to a length of 9·40 metres and a maximum depth of 3·00 metres (Fig. 3). Ceiling height varies from 2·25 to 3·50 metres.

The Rock Engravings

A kaleidoscopic frieze of engravings extending over an area of approximately 12 square metres covers the main vertical face of the sandstone wall. The upper edge of the decorated area is 2·20 metres and the lower 75 cm above extant ground level.

Technique: Three distinct engraving techniques have been utilized; drilling, abrasion, and pecking or pounding.

Drilled: By the simple act of continuously rotating a sharp implement, a round or oval hole ranging from 10 to 50 mm in diameter and 12 to 20 mm in depth was produced. Two hundred and sixty-eight drilled holes are scattered either singly or occasionally in pairs. Some have been incorporated into larger curvilinear designs. Their greatest concentration is restricted to the lower part of the decorated surface.

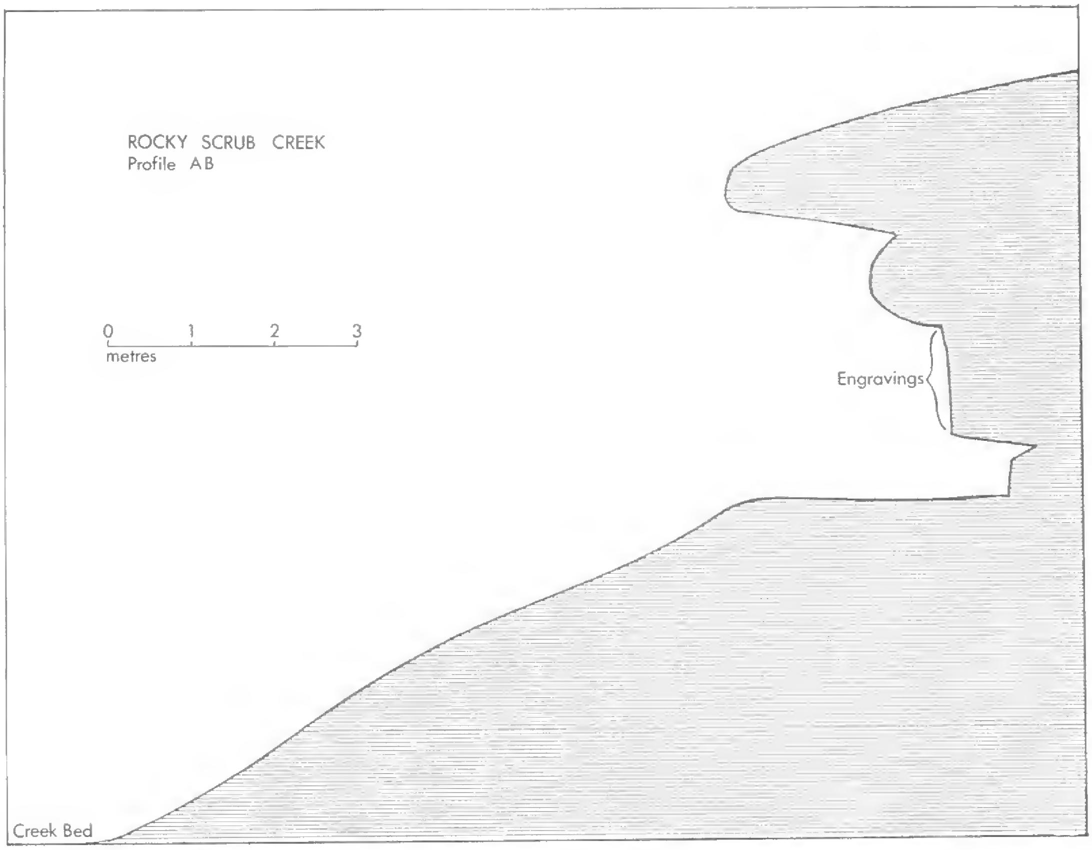

FIG. 2: Profile of Rocky Scrub Creek rock shelter.

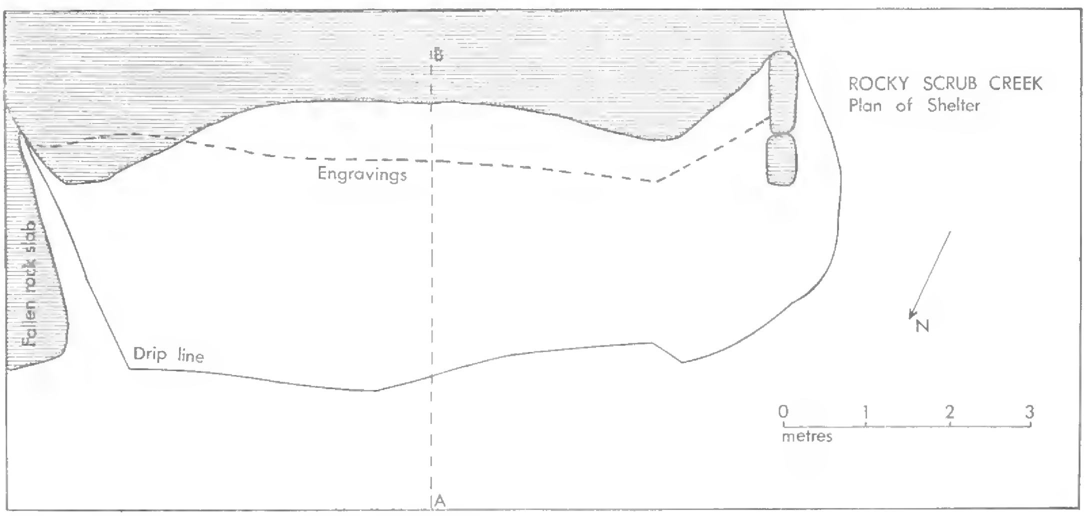

FIG. 3: Plan of Rocky Scrub Creek rock shelter.

Abraded: Abraded grooves with a U-shaped cross-section are formed by repeated rubbing with an appropriate implement. They are usually 10 to 15 mm in width and 8 to 13 mm in depth. Such grooves are generally used in outline designs, although simple, vertical linear grooves are also present.

Pecked: In this instance the grooves are manufactured by pounding or pecking with a stone or other implement. A series of contiguous rows of shallow indentations are combined to form a continuous groove. This technique is used for individual designs and also in association with abraded grooves. Scattered groups of individual pecked dots also occur.

STYLE: The Rocky Scrub Creek engravings are mainly linear, non-figurative in style. Consequently there is a wide range of variety in design; although on closer examination a number of basic recurrent circular and curvilinear designs appear. Table 1 indicates the relative frequency of design categories.

TABLE 1

FREQUENCY OF DESIGNS

Category	No.	Percentage
Single drilled holes	240	61·86
Simple linear grooves	54	14·43
Tracks	18	4·65
Ovals	3	0·77
Ovals + interior design	6	1·55
Inverted 'U'	1	0·26
Inverted 'U's + interior design	8	2·06
Other curvilinear designs	20	5·15
Other designs	38	8·77
Total	388	100·00

The visually most prominent designs are the inverted 'U's and ovals (Fig. 4, a–e). As a result of their size and position they completely dominate the numerically superior single drilled holes and simple linear grooves. Grooved outline tracks form a small but distinct representational group that is conspicuous among the non-figurative designs.

DISCUSSION

Evidence for engraved parietal art in coastal southeast Queensland and northern New South Wales east of the Great Dividing Range is meagre. Known sites are relatively rare.

Engravings occur on numerous isolated boulders in the bed of the Burnett River at Bingera in the Bundaberg district, 312 km (194 miles) north of the Rocky Scrub Creek shelter (Fig. 1). These have been known since at least 1876, and Tryon referred to them and illustrated some details in his original paper (1884, p. 48, pl. 12). R. H. Mathews (1901, p. 57) reported similar engravings in the bed of the same river near South Kolan 7·2 km

(4·5 miles) to the southwest.* This group had also been known to local residents since the early 1870's. Despite both published reports, neither site was adequately recorded. This has now been rectified at South Kolan, where a survey has been carried out by the Department of Aboriginal and Island Affairs because the site will soon disappear under the waters of a new dam.

Another engraved site on one of the Burnett River headwaters at Rawbelle Station 354 km (220 miles) north-northwest of Rocky Scrub Creek was also reported by Mathews (1901, p. 58). These engravings were similar in style and technique to those at Bingera and South Kolan. Several designs, tracks, drilled holes and ovals, are common to Rocky Scrub Creek and the Burnett River sites. At the latter sites a different technique has been used; designs are more varied and complex, and representational designs such as weapons and human feet are present.

G. K. Jackson (1939, p. 291) referred to the existence of engravings on coastal sandstone platforms at Point Cartwright and Caloundra (Moffat and Wickham Heads) some 145 km (90 miles) northeast of Rocky Scrub Creek (Fig. 1). By 1939 these had all been weathered away by wind and sea action. Although Jackson noted that the designs included kangaroo and dingo paws, and human and emu feet, no record or illustration was ever published. Except for the emu feet (tracks) which also appear at Rocky Scrub Creek these two sites are perhaps more closely related to those on the Burnett River.

In northern New South Wales about 206 km (128 miles) south of Rocky Scrub Creek (Fig. 1), Professor Isabel McBryde has recorded a number of art sites in the Clarence River valley near Grafton (McBryde, 1962, 1964). Included are shelters containing engravings at Seelands, Whiteman Creek, Upper Copmanhurst and Nobby's Creek, Copmanhurst. The latter is the most closely related to Rocky Scrub Creek, a fact already noted by Etheridge (1904, p. 272) and McBryde (1964, p. 207). Both sites share the basic inverted 'U' design, in simple form at Nobby's Creek and a much more elaborate form at Rocky Scrub Creek.

It is apparent that the Rocky Scrub Creek site while not closely related, can at least be marginally grouped with other engraved sites east of the Great Dividing Range between latitudes 24° and 30° south. The style at this site is easily distinguishable from the more elaborate engraved art styles on the western side of the Great Dividing Range as shown at Graman in northern New South Wales (McBryde, 1968, pl. 6B) and the central highlands of Queensland, notably in the Carnarvon Range, Upper Maranoa, and Upper Warrego Rivers. Again it is quite distinct from the outline figured art of the Sydney-Hawkesbury district.

Many of the features that appear to characterise rock engraving sites throughout the continent (Edwards, 1971, p. 358), such as proximity to a water supply, an occupation deposit, and heavy patination are present at Rocky Scrub Creek. The relative frequencies of design (Table 1) are not consistent with Edwards's central and south Australian sites (1971, p. 362, table 24 : 1), but this would be expected of an east coast site.

Chronologically the pecked technique is more recent than the abraded. In two cases pecked designs are partly superimposed over an earlier abraded design; in both instances they are placed within a grooved outline inverted 'U' (Fig. 4, a–b). Elsewhere existing

* It is possible that Bingera and South Kolan are the same site, no precise location was given by Tryon who did not visit the area himself.

abraded grooves are extended or joined together by pecked grooves. Patination in the pecked grooves is in general lighter in colour than in the abraded grooves.

Tryon's record indicates that with one exception, there has been little natural deterioration in the condition of the engravings over the period 1884 to 1972. The engraved surface is well sheltered and protected from rain and wind action. The area from which one small fragment had broken away before 1884 still appears relatively unweathered (Fig. 4, x). Because the edges of this exposed surface are less resistant to weathering an area of 100 cm^2 immediately to the right has begun to spall. It is likely to fall away in the near future.

Due to the proximity of the shelter to a mine access road the engravings have suffered greatly from the attention of European vandals. Names, initials and dates cover a large proportion of the surface, in one area completely obliterating the engravings that were present in 1884. In this respect it is pleasing to note that the Rocky Scrub Creek shelter was gazetted as a protected site under section 13 of the *Aboriginal Relics Preservation Act of* 1967, on 29 July 1971. These rock engravings therefore enjoy today, a higher degree of legal protection from human vandalism than they have had these past 87 years.

ACKNOWLEDGEMENTS

I wish to thank the Minister for Aboriginal and Island Affairs for granting a permit to record the site, and those members of the Queensland Museum staff who contributed their services; the late Mr M. E. McAnna, Mr A. J. Easton, Mrs C. Cameron, Mr R. G. Hardley, Miss S. Hiley, and Mrs E. L. Robinson.

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BIRDS OF FRASER ISLAND AND ADJACENT WATERS

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ABSTRACT

Two hundred birds are listed from Fraser Island, the waters of Hervey Bay and the island's Pacific Ocean shoreline. Notes on breeding are included where information is available.

Lying close to the mainland of southeast Queensland, Fraser Island has an area of 150,616 hectares. It is composed almost entirely of sand, the only hard rock exposed are the basalt outcrops at Indian Head, Waddy Point and Middle Rocks (Whitehouse, 1968). There are many lagoons, swamps, creeks, and a number of lakes which occur up to 100 metres above sea level. Seepage areas on to the beach are common on the ocean side of the island south of Indian Head. Most of the island is vegetated but bare sand is exposed on the frequent blowouts along its eastern side, especially in the area just south of Indian Head.

Plant species are numerous, some reaching their most northerly range, and others their most southerly (Francis, 1951; Blake, 1968). Coaldrake (1961) distinguishes 25 plant formations which he includes as wallum. The major ecosystems are those of the fore-dunes, hind-dunes, scrub-woodlands, wallum swamps and heaths, open forests, and rainforests (Anderson, in press). Blake (1968) describes the rainforests as 'quite well developed structurally though less complex than some communities on the mainland'. Mangroves occur in suitable situations along the western shores south of Wathumba Creek.

In the winter of 1962, a restricted programme of field-work was undertaken on Fraser Island in the area defined in the map (Fig. 1) by staff of the Queensland Museum (the late G. Mack, D. P. Vernon, the late M. E. McAnna, T. P. Tebble, and S. Breeden) with the approval of the Department of Primary Industries Fauna Branch. These Queensland Museum collections have been augmented by Miss M. Hawken's donations of beach-washed specimens and by specimens collected by D. H. Barry. Sources of information for this paper and their abbreviations used in the list are: the Queensland Museum collection (QM.); D. H. Barry collection for the Queensland Institute of Technology (QIT.); Royal Australasian Ornithologists Union list (RAOU.) (Bryant, 1931); Dorothy and George Makin (D.M., .GM.) and Miss N. Hopkin's (N.H.) list (Makin, 1968); and I. G. Filmer's

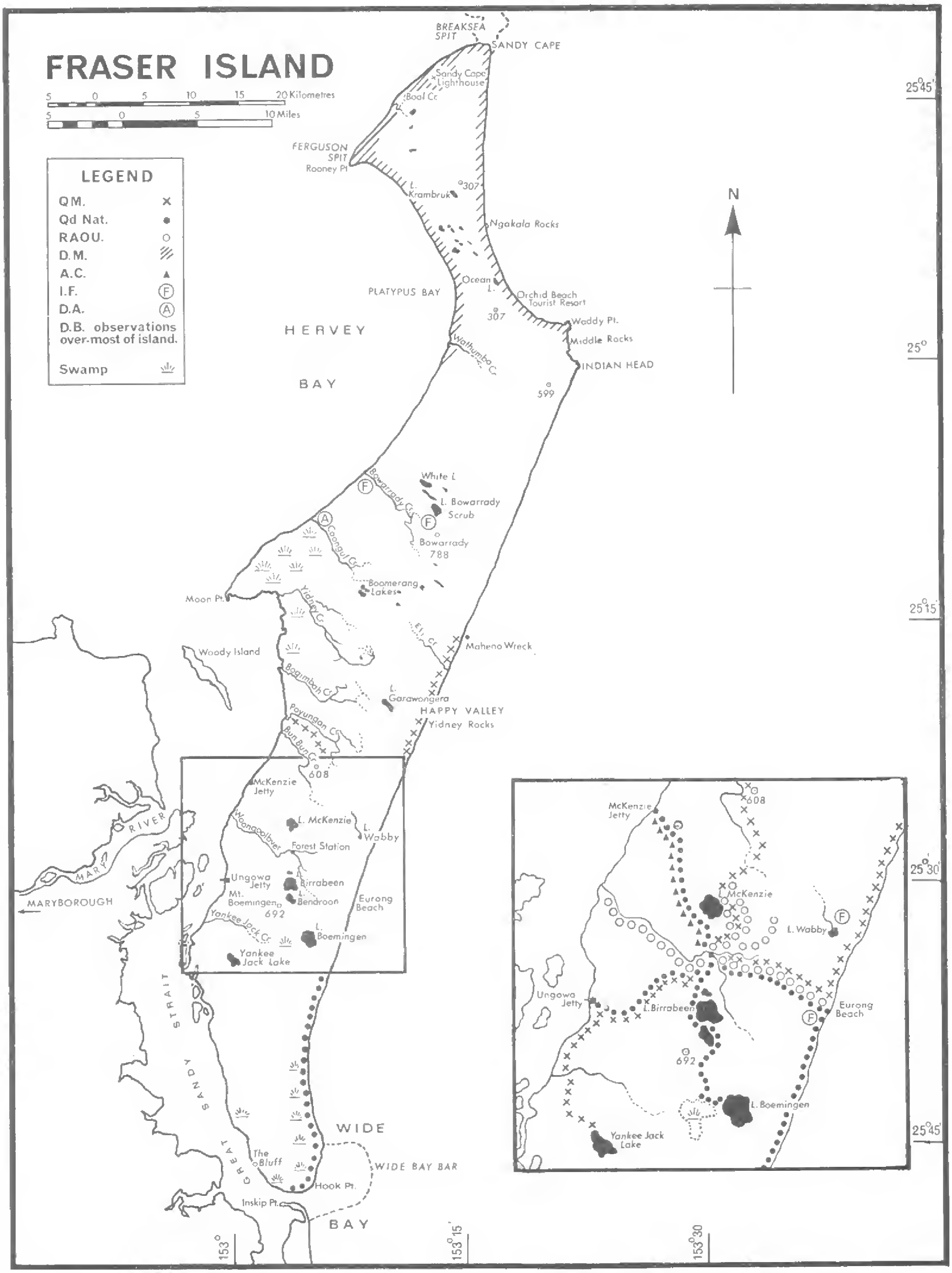

FIG. 1: Map of Fraser Island showing observation and collecting areas.

list (I.F.) (Filmer, 1971a, b). It also includes sightings made by members of the Queensland Naturalist's Club (Qd Nat.) during August 1971 and by A. H. Chisholm (A.C.) in 1922 (Chisholm, 1929). Sightings have been made by D. H. Barry (D.B.) between May 1969 and January 1972 and a single observation by Dale R. Anderson (D.A.).*

Nomenclature follows 'An Index of Australian Bird Names' compiled by C.S.I.R.O. Division of Wildlife Research (1969) with three exceptions and these are noted in the text. Where a specimen has been lodged in either the Queensland Museum or the Queensland Institute of Technology, a registration number is given followed by sex (if known), date of collection, and name of the collector except where a specimen was collected by the staff of the institution in which it is housed. A query (?) before an observer's initials indicates an unconfirmed identification; an asterisk (*) indicates that breeding of the species has been noted and month and year provided, if known; a cross (+) after the sex indicates that the collector noted that the gonads were 'enlarged' and the specimen was probably taken when in breeding or approaching breeding condition. Because most Queensland Museum specimens were collected during early winter, it was premature for breeding for most species. Specimens are all cabinet skins except where otherwise stated.

SYSTEMATIC LIST

Wandering albatross, *Diomedea exulans.* QM.O11791, skull, 12.v.1969, D. H. Barry; QM.O11792, skull, 12.v.1969, D. H. Barry; QIT.A7, skull.

Black-browed albatross, *Diomedea melanophris.* QM.O10872, 8.v.1967, M. Hawken (formerly identified as *D. chrysostoma*, see Marks, 1968); QM.O11484, 16.vi.1970, S. Peters; D.M., juvenile found dead; ? QIT.A8, skeleton, horny billsheaths fragmented.

White-capped albatross, *Diomedea cauta.* QM.O11793, skull, 12.x.1969, D. H. Barry.

Tahiti petrel, *Pterodroma rostrata rostrata.* QM.O11165, 12.v.1969, D. H. Barry.

Brown-headed petrel, *Pterodroma melanopus.* QM.O11004, feathered head, 8.v.1967, M. Hawken; QM.O11794, skull, 1.v.1971, D. H. Barry.

Wedge-tailed shearwater, *Puffinus pacificus.* QM.O11795, skull, 25.x.1969, D. H. Barry; QIT.A3, skull; D.M.

Short-tailed shearwater, *Puffinus tenuirostris.* QM. O10871, ♀, 8.v.1967, M. Hawken; QM.011796, skull, 25.x.1969, D. H. Barry; ? D.M.

Australian pelican, *Pelicanus conspicillatus.* QIT.A9, skull, Woody Is., Hervey Bay, 26.xii.1969.

Australian gannet *Morus serrator.* D.M.; N.H.; D.B.

Brown booby, *Sula leucogaster.* D.M.; N.H.; D.B.

Black cormorant, *Phalacrocorax carbo.* ? D.M.; D.B.

Little black cormorant, *Phalacrocorax sulcirostris.* Qd Nat.; ? N.H.

Pied cormorant, *Phalacrocorax varius.* Qd Nat.; ? D.M.

* While this paper was in press the authors became aware of a list of 65 species of birds observed in the southern part of Fraser I. on 27–28 October 1968 by E. E. Zillman (E.Z.) (Anon. 1968). Only additional species (7) and noteworthy confirmations (2) could be added to the present list at this stage.

Little pied cormorant, *Phalacrocorax melanoleucos.* RAOU.; Qd Nat.
Greater frigate-bird, *Fregata minor.* ? D.M.
Lesser frigate-bird, *Fregata aeriel.* ? D.M.; D.B.; E.Z.
Little grebe, *Podiceps novaehollandiae.* Qd Nat.; D.B.
White-faced heron, *Ardea novaehollandiae.* QM.O9230, ♀, 24.v.1962; RAOU.; D.M.; D.B.; I.F.
Mangrove heron, *Butorides striatus.* RAOU.
White egret, *Egretta alba.* RAOU.; ? D.M.
Plumed egret, *Egretta intermedia.* ? D.B.
Nankeen night heron, *Nycticorax caledonicus.* G.M.
Black bittern, *Dupetor flavicollis.* RAOU., * Oct. 1930.
Jabiru, *Xenorhynchus asiaticus.* RAOU.; D.M.
White ibis, *Threskiornis molucca.* D.M.; Qd Nat.
Straw-necked ibis, *Threskiornis spinicollis.* D.M.
Royal spoonbill, *Platalea regia.* D.M.
Black swan, *Cygnus atratus.* RAOU.; Qd Nat.
Black duck, *Anas superciliosa.* RAOU.; G.M.; D.B.; Qd Nat.
Grey teal, *Anas gibberfrons.* Qd Nat.
White-eyed duck, *Aythya australis.* E.Z.
Green pigmy goose, *Nettapus pulchellus.* D.B.
Musk duck, *Biziura lobata.* QM.O9335, ♀ +, 16.vi.1962; QM.O9336, ♂ (mounted), 16.vi.1962; QM.O9337, ♀ (mounted), 16.vi.1962; RAOU.; Qd Nat.; D.B.
Black-shouldered kite, *Elanus notatus.* D.M.
Fork-tailed kite, *Milvus migrans.* D.B.
Square-tailed kite, *Lophoictinia insura.* ? D.M.
Red-backed sea eagle, *Haliastur indus.* QM.O9449. 21.vi.1962; RAOU.; D.M.; N.H.; D.B.; Qd Nat.; I.F.
Whistling eagle, *Haliastur sphenurus.* QM.O9417, ♂ +, 3.vii.1962; QM.O9446, ♀, 3.vii.1962; RAOU.; D.M.; N.H.; D.B.; I.F.
Grey goshawk, *Accipiter novaehollandiae.* RAOU., * Oct. 1930; D.M., dead bird; D.B.; Qd Nat.
Australian goshawk, *Accipter fasciatus.* D.M.; Qd Nat.; I.F.
Collared sparrowhawk, *Accipiter cirrocephalus.* ? D.M.
Australian little eagle, *Hieraaetus morphnoides.* D.M.; Qd Nat.
Wedge-tailed eagle, *Aquila audax.* RAOU.; Qd Nat.
White-breasted sea-eagle, *Haliaeetus leucogaster.* RAOU., * Oct. 1930; D.M.; N.H.; D.B.; Qd Nat.
Osprey, *Pandion haliaetus.* RAOU.; D.M.; D.B.; Qd Nat., I.F.
Peregrine falcon, *Falco peregrinus.* D.M.; D.B.
Little falcon, *Falco longipennis.* D.M.
Nankeen kestrel, *Falco cenchroides.* D.M.; D.B.
Brown hawk, *Falco berigora.* QM.O9321, ♀, 15.vi.1962; D.M.; D.B.
Brown quail, *Synoicus ypsilophorus.* G.M.; Qd Nat.
King quail, *Excalfactoria chinensis.* A.C.

Painted quail, *Turnix varia.* D.M., dead bird; Qd Nat.

Brolga, *Grus rubicunda.* RAOU.

Marsh crake, *Porzana pusilla.* D.M., dead bird.

Pied oystercatcher, *Haematopus ostralegus.* QM.O9181, ♂, 26.v.1962; QM.O9217, ♀, 4.vi.1962; QM.O9240, ♀, 29.v.1962; QM.O9272, ♂, 7.vi.1962; QM.O9273, ♀, 7.vi.1962; QM.O9274, ♀, 7.vi.1962; QM.O9333, ♀, 14.vi.1962; RAOU.; D.M. *; N.H.; D.B.; Qd Nat.; I.F.

Spur-winged plover, *Vanellus novaehollandiae.* RAOU.; D.M.; N.H.; D.B.; Qd Nat.

Red-capped dotterel, *Charadrius alexandrinus.* QM.O9188, ♂, 27.v.1962; QM.O9189, ♂, 4.vi.1962; QM.O9225, ♂, 4.vi.1962; QM.O9263, ♀, 26.vi.1962; RAOU.; D.M.; N.H.; D.B.; Qd Nat., * July 1971; I.F.

Double-banded dotterel, *Charadrius bicinctus.* ? D.M.; ? D.B.

Mongolian sand dotterel, *Charadrius mongolus.* D.M.; N.H.

Large sand-dotterel, *Charadrius leschenaulti.* E.Z.

Eastern golden plover, *Pluvialis dominica.* RAOU.; D.M.

Turnstone, *Arenaria interpres.* D.M.; N.H.

Whimbrel, *Numenius phaeopus.* RAOU.; D.M.; N.H.; D.B., Qd Nat.

Eastern curlew, *Numenius madagascariensis.* RAOU.; D.M., D.B.; Qd Nat.; I.F.

Grey-tailed tatler, *Tringa brevipes.* QM.O9262, ♂, 4.vi.1962.

Sharp-tailed sandpiper, *Calidris acuminata.* E.Z.

Pectoral sandpiper, *Calidris melanotis.* D.B.

Red-necked stint, *Calidris ruficollis.* D.M.; N.H.

Black-tailed godwit, *Limosa limosa.* E.Z.

Bar-tailed godwit, *Limosa lapponica.* D.B.; ? D.M.

Southern stone curlew, *Burhinus magnirostris.* QM.O9229, 26.v.1962; RAOU.; D.M.; N.H.; D.B.; Qd Nat.

Beach stone curlew, *Esacus magnirostris.* D.M.; D.B.

Silver gull, *Larus novaehollandiae.* QM.O9327, ♂, 12.vi.1962; RAOU.; D.M.; N.H.; D.B.; Qd Nat.; I.F.

Caspian tern, *Hydroprogne caspia.* D.M.; I.F.

Gull-billed tern, *Sterna nilotica.* QM.O9334, ♀, 13.vi.1962.

Little tern, *Sterna albifrons.* D.B.; Qd Nat.; ? D.M.

Crested tern, *Sterna bergii.* QM.O9176, ♀, 24.v.1962; QM.O9177, ♂, 24.v.1962; QM.O9178, ♂, 24.v.1962; QM.O9179, ♂, 24.v.1962; QM.O9180, ♂, 25.v.1962; QM.O9211, ♂, 24.v.1962; QM.O9212, ♀, 24.v.1962; QM.O9213, ♀, 24.v.1962; QM.O9214, ♀, 24.v.1962; QM.O9215, ♂, 24.v.1962; QM.O9216, ♂, 24.v.1962; QM.O9233, ♂, 24.v.1962; QM.O9234 ♀, 24.v.1962; QM.O9335, ♂, 25.v.1962; QM.O9275, ♂, 24.vi.1962; RAOU.; D.M.; N.H.; D.B.; Qd Nat.; I.F.

Lesser crested tern, *Sterna bengalensis.* E.Z.

Noddy, *Anous* sp. ? D.M.

Red-crowned pigeon, *Ptilinopus regina.* RAOU.; D.M.; N.H.; A.C.

Wompoo pigeon, *Megaloprepia magnifica.* RAOU.; D.M.; A.C.

Top-knot pigeon, *Lopholaimus antarcticus.* QM.O9330, ♀, 18.vi.1962; QM.O9331, ♂, 18.vi.1962; RAOU.; D.M.; N.H.; A.C.; D.B.

White-headed pigeon, *Columba norfolciensis.* RAOU,; A.C.

Domestic pigeon, *Columba livia.* Qd Nat.

Brown pigeon, *Macropygia amboinensis.* QM.O9319, ♀, 15.vi.1962; QM.O9320, ♀, 15.vi.1962; RAOU.; D.M., * June 1962; A.C.; D.B.; Qd Nat.

Bar-shouldered dove, *Geopelia humeralis.* QM.O9182, ♂, 2.vi.1962; QM.O9183, ♀, 26.v.1962; QM.O9184, ♂, 28.vi.1962; QM.O9185, ♂, 2.vi.1962; QM.O9186, ♂, 26.v.1962; QM.O9218, ♂, 24.v.1962; QM.O9232, ♀, 4.vi.1962; RAOU., nest observed, Oct. 1930; D.M.; D.B.; A.C.; Qd Nat.; I.F.

Peaceful dove, *Geopelia striata.* RAOU.

Green-winged pigeon, *Chalcophaps indica.* QM. O9187, ♂, 2.vi.1962; RAOU.; D.M. *; A.C.; D.B.

Common bronzewing pigeon, *Phaps chalcoptera.* RAOU.

Brush bronzewing pigeon, *Phaps elegans.* A.C.; I.G. Filmer (pers. com.), 'one pair was flushed from a track just north of Lake Wabby' and 'another pair from a drier forest near the mouth of Bowarrady Creek'.

Rainbow lorikeet, *Trichoglossus haematodus.* QM.O9227, ♂, 24.v.1962; QM.O9441, ♂, 21.vi.1962; QM.O9442, ♂ 21.vi.1962; D.M.; G.M.; N.H.; I.F.

Scaly-breasted lorikeet, *Trichoglossus chlorolepidotus.* D.M.

Little lorikeet, *Glossopsitta pusilla.* QM.O9324, ♂, 18.vi.1962.

Yellow-tailed black cockatoo, *Calyptorhynchus funereus.* D.M.; D.B.

Glossy black cockatoo, *Calyptorhynchus lathami.* Qd Nat.; D.B.

Sulphur-crested cockatoo, *Cacatua galerita.* QM.O9231. ♂, 1.vi.1962; QM.O9328, ♀, 16.vi.1962; QM.O9350, ♂ (mounted), 21.vi.1962; QM.O9418, ♀, 21.vi.1962; RAOU.; D.M.; D.B. Qd Nat.; I.F.

Red-winged parrot, *Aprosmictus erythropterus.* RAOU.

King parrot, *Aprosmictus scapularis.* RAOU.; Qd Nat.

Ground parrot, *Pezoporus wallicus.* A.C.; D.R. Anderson (in association with two foresters) observed on 9.1.1972 'One bird was flushed from the Coongul Creek firebreak in low *Banksia aemula* tree heath'. A. Herrenberg, 1966, reported birds 'in swamp $\frac{3}{4}$ mile south of Poyungan Creek.'

Pallid cuckoo, *Cuculus pallidus.* A.C.; E.Z.

Brush cuckoo, *Cacomantis variolosus.* D.M.; N.H.

Fan-tailed cuckoo, *Cacomantis pyrrhophanus.* QM.O9201, ♀, 1.vi.1962; RAOU.; D.M., dead bird, 1964.; I.F.

Horsfield bronze cuckoo, *Chrysococcyx basalis.* ? D.M.

Golden bronze cuckoo, *Chrysococcyx lucidus plagosus.* (C.S.I.R.O. list—*Chrysococcyx plagosus*) QM.O9815, specimen found dead by D. Makin and presented 22.ii.1964. Formerly identified as *Chalcites lucidus* (see Makin, 1968); I.F.

Koel, *Eudynamys scolopacea.* RAOU.; D.M.; A.C.; Qd Nat.; D.B.

Channel-billed cuckoo, *Scythrops novaehollandiae.* D.M.

Pheasant coucal *Centropus phasianinus.* QM.O9254, ♂, 25.v.1962; D.M.; D.B.; Qd Nat.; I.F.

Powerful owl, *Ninox strenua* D.B., 16.i.1972, saw 'a large owl with a wingspan of approximately $\frac{3}{4}$ metre in rainforest'.

Barking owl, *Ninox connivens.* G.M.
Boobook owl, *Ninox novaeseelandiae.* QM.O9258, ♀, 3.vi.1962; D.M.; D.B.; Qd Nat.
Barn owl, *Tyto alba.* QM.O9259, ♂, 6.vi.1962; D.M.
Tawny frogmouth, *Podargus strigoides.* QM.O9255, ♂, 6.vi.1962;QM.O9256, ♀, 30.v.1962; QM.O9257, ♂, 3.vi.1962; D.M., * Dec. 1965; D.B.
Owlet nightjar, *Aegotheles cristatus.* G.M., A.C.
White-throated nightjar, *Eurostopodus mystacalis.* A.C.; Qd Nat.
White-tailed nightjar, *Caprimulgus macrurus.* D.M.; N.H.; A.C.
Spine-tailed swift, *Hirundapus caudacutus.* D.M.; N.H.; D.B.; A.C.
Fork-tailed swift, *Apus pacificus.* D.M.
Azure kingfisher, *Alcyone azurea.* RAOU, * Oct. 1930; D.M.; Qd Nat.
Laughing kookaburra, *Dacelo gigas.* QM.O9202, 2.vi.1962; RAOU.; D.M.; N.H.; D.B.; Qd Nat.
Forest kingfisher, *Halcyon macleayi.* RAOU.; D.M.; I.F.
Red-backed kingfisher, *Halcyon pyrrhopygia.* D.M.
Sacred kingfisher, *Halcyon sancta.* QM. O9224, ♂, 26.v.1962; QM.O9245, ♀, 23.v.1962; D.M.; N.H.; I.F.
Mangrove kingfisher, *Halcyon chloris.* Qd Nat.; A.C.
Rainbow bee-eater, *Merops ornatus.* QM.O9277, ♂, 7.vi.1962; QM.O9463, ♂, 3.vii.1962; RAOU.; D.M.; N.H.; D.B.; Qd Nat.; I.F.
Dollar-bird, *Eurystomus orientalis.* RAOU.; D.M.; A.C.
Noisy pitta, *Pitta versicolor.* QM.O9329, ♀, 12.vi.1962.
Singing bush lark, *Mirafra javanica.* E.Z. (as Brown field lark).
Welcome swallow, *Hirundo neoxena.* QM.O9318, ♂, 9.vi.1962; RAOU.; * Oct. 1930; D.M. *; N.H.; D.B.
Barn swallow, *Hirundo rustica.* D.M.; Qd Nat.
Tree martin, *Petrochelidon nigricans.* QM.O9174, ♀, 5.vi.1962; QM.O9271, ♀, 5.vi.1962; RAOU.; D.M.
Fairy martin, *Petrochelidon ariel.* D.M.; ? I.F.
Australian pipit, *Anthus novaeseelandiae.* QM.O9267, ♂ +, 4.vi.1962; D.M.; N.H.; D.B.; I.F.
Black-faced cuckoo-shrike, *Coracina novaehollandiae.* QM.O9198, ♂, 1.vi.1962; D.M., * Dec. 1961; N.H.; D.B.
Little cuckoo-shrike, *Coracina papuensis robusta.* (C.S.I.R.O. list—*Coracina robusta*) RAOU.; D.M.; Qd Nat.
Cicada-bird, *Edoliisoma tenuirostre.* D.M., * 'almost certainly breeds . . . twice a male was heard giving a song performance'.
Varied triller, *Lalage leucomela.* RAOU.; D.M.; N.H.; Qd Nat.
Golden-headed fantail-warbler, *Cisticola exilis.* Qd Nat.
Tawny grassbird, *Megalurus timoriensis.* RAOU.; D.M.; G.M.
Variegated wren, *Malurus lamberti.* ? D.B., 'A wren was seen with some blue on it'.
Red-backed wren, *Malurus melanocephalus.* QM.O9210, ♂, 27.v.1962; QM.O9253, ♂, 3.vi.1962; D.M., * July, August 1965; N.H.; Qd Nat., * July 1971.; I.F.; A.C.; D.B.
White-throated warbler, *Gerygone olivacea.* D.M.; A.C.

Mangrove warbler, *Gerygone levigaster.* (C.S.I.R.O. list—Buff-breasted Warbler) A.C.; Qd Nat., * 18.vii.1971.

Brown thornbill, *Acanthiza pusilla.* Qd Nat.; I.F.

Buff-rumped thornbill, *Acanthiza reguloides.* I.F., identified by call only.

White-browed scrubwren, *Sericornis frontalis.* I.F. identified by call only.

Large-billed scrubwren, *Sericornis magnirostris.* QM.O9325, ♂, 14.vi.1962; RAOU., * Oct. 1930; observed feeding a Bronze Cuckoo, *Chrysosoccyx* sp., 20.vii.1971, M. Hawken.

Rose robin, *Petroica rosea.* D.M.

Southern yellow robin, *Eopsaltria australis.* QM.O9226, ♂, 12.vi.1962; QM.O9243, ♀, 1.vi.1962; RAOU.; D.M., * July; D.B.; I.F.

Grey fantail, *Rhipidura fuliginosa.* QM.O9268. ♂, 30.v.1962; D.M.; Qd Nat.

Rufous fantail, *Rhipidura rufifrons.* D.M.; I.F.

Willie wagtail, *Rhipidura leucophrys.* QM.O9270, ♂ (mounted), 6.vi.1962; RAOU.; D.M.; D.B.; Qd Nat.; I.F.

Leaden flycatcher, *Myiagra rubecula.* D.M.; N.H.; Qd Nat.

Satin flycatcher, *Myiagra cyanoleuca.* ? RAOU. ('It is suggested in the 1930 (R.A.O.U.) list that a *Myiagra* heard calling was probably *M. cyanoleuca* . . . but the *Myiagra* I saw was the Leaden Flycatcher.'—A. H. Chisholm, 1936).

Shining flycatcher, *Myiagra alecto.* ? A.C., 'Possibly the Shining Flycatcher also reaches the island occasionally for Mr Walter Petrie spoke of having seen a bird answering its description in the mangroves.'—A. H. Chisholm (1936).

Restless flycatcher, *Seisura inquieta.* D.M.; Qd Nat.

Black-faced flycatcher, *Monarcha frater.* D.M.

Spectacled flycatcher, *Monarcha trivirgata.* RAOU., * Oct. 1930.

White-eared flycatcher, *Monarcha leucotis.* RAOU., * Oct. 1930; D.M.

Golden whistler, *Pachycephala pectoralis.* D.M.; N.H.; A.C.; Qd Nat.; I.F.

Rufous whistler, *Pachycephala rufiventris.* D.M.; N.H.; A.C.; Qd Nat.; I.F.

Grey shrike-thrush, *Colluricincla harmonica.* QM.O9203, ♀, 26.v.1962; RAOU.; D.M.; N.H.; Qd Nat., * July 1971.; I.F.; D.B.

Rufous shrike-thrush, *Colluricincla megarhyncha.* QM.O9251, ♂, RAOU., * Oct. 1930; Qd Nat., * July 1971.

Eastern whipbird, *Psophodes olivaceus.* QM.O9322, ♀, 19.vi.1962; RAOU., * Oct. 1930; A.C.; Qd Nat.; I.F.; D.B.

White-throated tree-creeper, *Climacteris leucophaea.* Qd Nat.

Mistletoe-bird, *Dicaeum hirundinaceum.* QM.O9209, ♀, 27.v.1962; QM.O9250, ♂, 4.vi.1962; RAOU.; D.M., *; I.F.

Spotted pardalote, *Pardalotus punctatus.* D. M., * 'Nest tunnels were made in sandy cutting of road'; N.H.; Qd Nat., * July 1971.

Black-headed pardalote. *Pardalotus melanocephalus.* D.M., * July 1963.; I.F.

Grey-breasted silvereye, *Zosterops lateralis.* QM.O9269, ♀, 29.v.1962; RAOU.; D.M.; N.H.; D.B.; Qd Nat.; I.F.

Brown honeyeater, *Lichmera indistincta.* QM.O9207, ♂ +, 26.v.1962; QM.O9208, ♂ +, 27.v.1962; QM.O9222, ♂, 23.v.1962; RAOU.; D.M.; N.H.; A.C.; Qd Nat.; I.F.

Dusky honeyeater, *Myzomela obscura.* QM.O9223, ♂, 26.v.1962; A.C.

Scarlet honeyeater, *Myzomela sanquinolenta.* QM.O9224, ♂, 26.v.1962; QM.O9246, ♂, 5.vi.1962; QM.O9247, juv. ♂, 28.v.1962; QM.O9248, ♂, 27.v.1962; QM.O9326, ♂, 12.vi.1962; D.M., * July, August; N.H.; Qd Nat.

Lewin honeyeater, *Meliphaga lewinii.* QM.O9249, 26.v.1962; QM.O9266, ♀, 27.v.1962; RAOU., * Oct. 1930; D.M., * July, Aug., Sept.; N.H.; Qd Nat.; I.F.

Mangrove honeyeater, *Meliphaga fasciogularis.* A.C.

Yellow-faced honeyeater, *Meliphaga chrysops.* D.M.; I.F.

White-throated honeyeater, *Melithreptus albogularis.* D.M.; N.H.; Qd Nat.; I.F.

Blue-faced honeyeater, *Entomyzon cyanotis.* QM.O9200, ♀, 2.vi.1962; RAOU., * Oct. 1930; D.M.; N.H.; Qd Nat.

Little friar-bird, *Philemon citreogularis.* RAOU.; D.M.

Noisy friar-bird, *Philemon corniculatus.* QM.O9260, ♀, 27.v.1962; QM.O9261, ♂, 27.v.1962; RAOU., * Oct. 1930; D.M.; N.H.; D.B.; Qd Nat.; I.F.

White-cheeked honeyeater, *Phlidonyris niger.* QM.O9191, ♂ +, 23.v.1962; QM.O9192, ♂ +, 25.v.1962; QM.O9193, ♂, 23.v.1962; QM.O9194, ♂ +, 27.v.1962; QM.O9219, ♂ +, 23.v.1962; QM.O9241 ♂ +, 25.v.1962; QM.O9242, ♂ +, 28.v.1962; QM.O11753, imm., 6.x.1971, C.A.C. Cameron; RAOU.; D.M., * May; N.H.; A.C.; D.B.; Qd Nat., * July 1971; I.F.

Noisy miner, *Manorina melanocephala.* Qd Nat.

Little wattle-bird, *Anthochaera chrysoptera.* Qd Nat.; I.F.

Red-browed finch, *Aegintha temporalis.* D.M., * July; N.H.; Qd Nat., * July, 1971; D.B.

Chestnut-breasted finch, *Lonchura castaneothorax.* D.M.

House sparrow, *Passer domesticus.* D.M.

Gold finch, *Carduelis carduelis.* A. Herrenberg reported 'A small flock in residence for a short period at Happy Valley'.

Starling, *Sturnus vulgaris.* D.M.

Olive-backed oriole, *Oriolus sagittatus.* QM.O9265, ♀, 27.v.1962; D.M., * July 1963; N.H.; Qd Nat.

Southern fig bird, *Specotheres vieilloti.* E.Z.

Spangled drongo, *Dicrurus bracteatus.* QM.O9197, ♀, 26.v.1962; QM.O9252, ♂, 25.v.1962; QM.O9276, ♀, 7.vi.1962; RAOU.; D.M.; N.H.; A.C.

Magpie lark, *Grallina cyanoleuca.* QM.O9278, ♀, 7.vi.1962; D.B.

White-breasted woodswallow, *Artamus leucorhynchus.* D.M.; G.M.; I.F.

Masked woodswallow, *Artamus personatus.* D.M.

White-browed woodswallow, *Artamus superciliosus.* D.M.

Dusky woodswallow, *Artamus cyanopterus.* QM.O9175, ♀, 4.vi.1962; QM.O9236, ♀, 5.vi.1962; QM.O9237, ♀, 4.vi.1962; QM.O9238, ♀, 4.vi.1962; QM.O9239, ♂, 5.vi.1962; D.M.

Pied butcher-bird, *Cracticus nigrogularis.* RAOU.; D.M.; I.F.; D.B.

Grey butcher-bird, *Cracticus torquatus.* D.M., *; N.H.; I.F.

Black-backed magpie, *Gymnorhina tibicen.* D.M.

Regent bower-bird, *Sericulus chrysocephalus.* ? ♀, G.M.; ? ♂, 18.vii.1971, M. Hawken observed a 'yellow and black bird about the size of a Bower-bird near the forest station'.

Australian raven, *Corvus coronoides.* Qd Nat.

Australian crow, *Corvus orru.* QM.O9199, ♀, 5.vi.1962; D.M.; N.H.; D.B.; Qd Nat.

CONCLUSIONS

Only 200 bird species are known to occur on the 125 kilometre long island, not many more than half the number recorded for the Brisbane and Moreton Bay area (Vernon, 1968). This paucity was first noted by Bryant (1931, p. 181) when he wrote 'As regards bird life, Fraser Island was somewhat of a disappointment'. The dearth of water bird species could be due to a shortage of organic matter both animal and plant in the sand-filtered water of creeks and lakes.

Although many species not previously recorded from Fraser Island are included in this paper, considerable future additions are expected of tube-nosed birds, migrant waders, perching birds, and others. Recent finds of beach-washed specimens of *Pterodroma rostrata rostrata* and *Pterodroma melanops* added two new species to the Queensland list. (McKean and Vernon, 1971).

It is surprising that some genera well represented on the nearby mainland do not appear to have colonised the island. Fraser Island is the northern limit of *Pezoporus wallicus* and *Biziura lobata* and approximately the southern limit of *Hirundo rustica* and *Myzomela obscura* in eastern Australia.

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SOME SUBLITTORAL ASCIDIANS IN MORETON BAY, AND THEIR SEASONAL OCCURRENCE

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ABSTRACT

Populations of 25 species from a limited area south of Peel Island are reported on. Five new species of the family Molgulidae are described. An unusually large number of small free living species is present, especially in the families Agnesiidae and Molgulidae, characterised by spiral branchial stigmata. Seasonal variations have been assessed from collections made at 3 monthly intervals (from March 1970 to September 1971). Most species disappear from the area in March and, for all except 2 species which are present throughout the year, enlistment in succeeding months is apparently from areas beyond the location surveyed. It is suggested that the climatic conditions, which appear to effect an annual mortality, favour small, rapidly maturing species which are able to contribute juveniles to the populations during their seasonal occurrence.

The ascidian fauna of a small area to the south of Peel Island in the southern part of Moreton Bay, Queensland, is reported on.

The collections were made in connection with a survey of the benthic fauna of the Bay being conducted by Professor W. Stephenson of the Department of Zoology in the University of Queensland; and the material was obtained from Van Veen grab samples sieved through 1·0 mm wire mesh screens. Information on the stations investigated is given on p. 253.

SPECIES LIST

APLOUSOBRANCHIA

CLAVELINIDAE

HOLOZOINAE

Sycozoa pedunculata

PHLEBOBRANCHIA

ASCIDIIDAE

Ascidia aclara
Ascidia sydneyensis

AGNESIIDAE

Agnesia glaciata
Adagnesia opaca

STOLIDOBRANCHIA

STYELIDAE

BOTRYLLINAE

Botrylloides nigrum

STYELINAE

Cnemidocarpa floccosa
Styela plicata
Styela stolonifera
Styela ramificata
Polycarpa tinctor
Polycarpa fungiformis
Polycarpa pedunculata

PYURIDAE

Pyura vittata
Microcosmus spinifera
Microcosmus exasperatus
Microcosmus australis
Microcosmus stolonifera
Microcosmus nichollsi

MOLGULIDAE

Molgula sabulosa
Molgula exigua
Molgula rima
Molgula sphaera
Molgula diversa
Eugyra moretonensis

In addition to the species in the present collections, the following have been recorded from Moreton Bay:

Podoclavella australis (new record: west of Myora off Dunwich, 153°4′28″E., 27°14′30″S., muddy grit, 24 ft, 18.vii.67, with larvae in brood pouch)
Eudistoma elongata; Kott, 1957
Ritterella dispar; Kott, 1957 (< *R. proliferus*; Kott, 1969)
Perophora bermudiensis; Kott, 1964
Phallusia depressiuscula; Kott, 1964
Styela orbicularis; Kott, 1964
Polycarpa longiformis; Kott, 1966
Polycarpa attollens; Kott, 1952
Polycarpa pedata; Kott, 1964
Polyandrocarpa latericius; Kott, 1964
Pyura pachydermatina; Kott, 1964
Herdmania momus; Kott, 1952, 1964

These species have been taken intertidally and by dredge from different parts of the Bay. They are, however, all fixed species. The intertidal aplousobranch fauna of Moreton Bay has not yet been properly sampled.

SYSTEMATIC DISCUSSION

A formal listing of material examined is given only in the case of new species; for other species this information can be derived from Table 1. Specimens have been lodged in the Queensland Museum (QM) collections.

Sycozoa pedunculata (Quoy and Gaimard)

Aplidium pedunculatum Quoy and Gaimard, 1834, p. 626.
[non] *Aplidium pendunculatum* Cunningham, 1871, p. 490 (< *S.sigillinoides* Lesson).
[non] *Colella pedunculata* Herdman, 1886, p. 74. Pfeffer, 1889, p. 4 (40); 1890, p. 499. Sluiter, 1900, p. 5; 1906, p. 6.
Colella pedunculata Caullery, 1908, pp. 14, 30 (specimen from King George Sound).
Colella tenuicaulis Herdman, 1899, p. 64.
Sycozoa tenuicaulis Brewin, 1953, p. 57. Kott, 1957, p. 99; 1972b, p. 8. Millar, 1963, p. 707.
Sycozoa sigillinoides Michaelsen, 1924, p. 288 (Australian specimens); 1930, p. 505 (non *S. sigillinoides* Lesson, 1830)

RECORDS: Southwestern Australia, South Australia, Victoria, New South Wales and Queensland.

DESCRIPTION: The common cloacal canals open around the free end of the colony.

REMARKS: *Sycozoa pedunculata* has been regarded as a synonym of the Antarctic species *S. sigillinoides* (see Kott, 1969). The range of the Antarctic species, therefore, apparently extended across the south coast of Australia where it overlapped the range of the Australian *S. tenuicaulis*, having been recorded from (1) the coast of Western Australia

at Cockburn Sound (*S. sigillinoides*: Michaelsen, 1930) at King George Sound (*S. sigillinoides*; Michaelsen, 1930 and *Aplidium pedunculatum* Quoy and Gaimard, 1834); (2) the Victorian coast at Westernport (*A. pedunculatum* Quoy and Gaimard, 1834, and *S. sigillinoides*; Michaelsen, 1924); and (3) the eastern Tasmanian coast and Bass Strait (*S. sigillinoides*; Michaelsen, 1924).

The antarctic species *S. sigillinoides* is distinguished from the Australian *S. tenuicaulis* by the presence of a terminal cloacal chamber with a single cloacal opening, as opposed to the ring of slit-like common cloacal openings around the free end of the head in the Australian species. The larvae of both species have an otolith but no ocellus and have the usual three triradiate papillae and adhesive suckers anteriorly. *S. sigillinoides*, however, has a larval form with a long slender tail at least one and a half times as long as the circumference of the larval body (Kott, 1969), while in *S. tenuicaulis* the tail is wider and extends only three-quarters of the way around the larva (Brewin, 1953).

A review of the descriptions of Australian specimens previously regarded as synonyms of the antarctic species has shown that they are in fact identical with Herdman's species *S. tenuicaulis*. Caullery (1908) compared the holotype of *Aplidium pedunculatum* Quoy and Gaimard, 1834, from King George Sound with specimens from the Cape Horn expedition and considered them conspecific. Caullery figured the larva of this species (fig. 7, p. 17) and although he does not identify the actual specimen from which he took his illustration it is most probable that it was the holotype of *A. pedunculatum* (in which he notes there are brood pouches containing about 12 embryos) rather than the magellanic material which he observed was not so well preserved. The larva illustrated shows the short tail typical of the Australian *Colella tenuicaulis* Herdman. There is no evidence that the specimens identified as *S. sigillinoides* by Michaelsen, from the Cockburn Sound and King George Sound in Western Australia (Michaelsen, 1930) and also those from Victoria and from Tasmania (Michaelsen, 1924) are not similarly identical. Herdman's species is therefore undoubtedly identical with *S. pedunculata* (Quoy and Gaimard).

Sycozoa sigillinoides; Brewin, 1952, and Michaelsen, 1924, both from New Zealand and *Sycozoa umbellata* Michaelsen, 1898, and *S. sigillinoides typica* Michaelsen, 1907, from the magellanic region all have the same colony form. The systems are similar to those of *S. pedunculata* with slit-like common cloacal openings around the anterior end of the head covered by a 'scale-like' flap of test (see Michaelsen, 1924). These species have an 'umbellate' colony form and probably should be assigned to the species *Sycozoa umbellata* Michaelsen recorded from New Zealand and from the magellanic region.

Sycozoa umbellata cf. *kophameli* Michaelsen, 1907, from the magellanic region has the single terminal common cloacal opening and undoubtedly should be referred to *S. sigillinoides*. The specimens described by Herdman (1886), from Kerguelen and Heard Islands and from the magellanic region all appear to be identical and have the long-tailed larva of this antarctic and magellanic species.

S. pedunculata occurs at depths of less than 300 metres on the continental shelf, while *S. sigillinoides* occurs at greater depths.

Seasonal Variation: Several small typical specimens, with rooted stalks and inverted conical heads, were taken from Areas II and III in September 1971 only.

Ascidia aclara Kott

(Figs. 1–4)

Ascidia aclara Kott, 1952, p. 309; 1972b, p. 27 and synonymy.
[?] *Styelopsis scaevola* Sluiter, 1904, p. 89.

RECORDS: St Vincent Gulf; Lakes Entrance; Port Phillip Bay; Moreton Bay (end of deep water trough approaching Brisbane River mouth where not much tidal or other current flow, coll. Stephenson et al, specimens 6 to 7 cm long; 13.xii.62, 12 m, west of Hope Banks; 13.xii.62, 2 m, ½ mile E. of middle of St Helena I., S. beacon on north of Green I.; sand and mud with shell, 8 m, 1½ miles east of S. beacon on St Helena I., not much tide run).

? Ceram Sea, 32 m, sand and small stones (*S. scaevola* Sluiter, 1904).

DESCRIPTION: Most of the specimens in this collection are smaller than those previously available and their dorso-ventral dimension is often greater than their length. The branchial and atrial tubes are of the usual form and slightly to the left of the mid-dorsal line. The atrial tube is up to 4 times the length of the branchial tube. In several specimens there is a small gastropod in the base of the atrial tube.

The body musculature is distinctive with 3 short wide parallel bands of muscle fibres extending dorso-ventrally in the middle of the right side of the body. The corresponding bands on the left are shorter, do not extend over the visceral mass, and extend across the mid-dorsal line with the exception of the middle band which terminates at the base of the atrial aperture. The dorsal ganglion is mid-dorsal and is covered by the anterior extent of the dorsal lamina and by the branchial fold where it is drawn across onto the prepharyngeal area to the right of the mid-line. The dorsal tubercle has an S-shaped opening and, with the neural gland, is displaced to the right to open just posterior to the point where the apex of the branchial fold is attached to the prepharyngeal area. The dorsal lamina is plain-edged, and ribbed on the left side. It is located at the base of the branchial fold on its right side, and terminates at the prepharyngeal band in the mid-line. The branchial fold is formed by the anterior distortion of the left wall of the branchial sac as the dorsal section of its origin from the left side of the prepharyngeal area doubles back into a loop across the mid line onto the right side of the body. The edge of the branchial fold is, therefore, to the right of the dorsal line anteriorly, but gradually crosses the mid-line and is on the left for the greater part of its length, projecting into the left side of the pharyngeal cavity and its outer concavity accommodates the thickened body wall and the gut. The fold is associated with considerable dorso-ventral shortening of the left side of the body. The endostyle therefore appears to be half way up the left side of the body, the visceral mass is confined to the region dorsal to the endostyle, while the ventral border of the body is actually occupied by a longitudinal axis well to the right of the endostyle. It has already been observed that the muscles on the left side of the body are shortened. The gut extends anteriorly in a straight line from the oesophagus. The stomach is small, rounded and smooth. The intestine forms a very short narrow loop only occupying the distal one-half of its length. The equally short rectum extends anteriorly to form a secondary narrow loop. The gut and gonads all form a tight visceral mass embedded in the thickened body wall associated with the shortened left side of the body.

REMARKS: *Styelopsis scaevola* Sluiter is suggested as a synonym of this species since the body musculature and the arrangements of internal longitudinal vessels in the branchial sac are identical with those of the present species. Sluiter did not describe the characteristic test tubes nor the anterior origin of the branchial fold and there is some difficulty in interpreting his account of the gut and gonads. The synonmy, therefore, is not confirmed.

The morphological modifications in this species of *Ascidia* are quite unique and the stiff brittle test is also unique for the genus, and is associated with highly specialised body musculature. The species appears to be adapted for a life on the sea floor, but unless specimens are found in the open sea its widely separated records from bays and estuaries indicate a highly specialised habitat and suggest that it is a relict species.

The function of the test tubes in providing a microenvironment outside the apertures is clear and it is of interest that these maintain the usual relationship for the apertures of bottom living forms with one another and with the substrate. Thus the atrial tube is very much higher than the branchial tube (Kott, 1969a, 1969b).

In this species the unique decrease in dorso-ventral dimension of the left side of the body has forced the right side of the body into a high arc. The body is consequently dorso-ventrally flattened and is stable when lying on the wide ventral part of the right side. The mid-dorsal line and its associated apertures are thus on the upper surface and directed upwards rather than at the side as in more typical laterally flattened phlebobranchia which lie on their left side. This adaptation is probably associated with the habitat of the species on sandy sediments, which could be mobile.

SEASONAL VARIATIONS: The species was absent in March 1970 but was taken from Area II in June. There was not any appreciable increase in numbers in September although the size of the individuals had increased. Only a single specimen was present in December 1970 and the species was absent from all stations during March 1971. A relatively high number of the species reappeared in the samples in June 1971 and ranged in size from 0·8 to 2 cm. It must be assumed that a population resettled in late March or early April 1971 and grew to at least 2 cm in two months. The relatively small number of specimens present in June 1970 suggests that some physical condition could have inhibited settlement in that year. In 1971, however, the species is present in greater density and it is possible that breeding populations are established.

Ascidia sydneyensis Stimpson

Ascidia sydneyensis Stimpson, 1855, p. 387. Kott, 1972b, p. 24 and synonymy.

RECORDS: (See Kott, 1972b).

DESCRIPTION: (See Kott, 1972b). Large (4–5 cm) lying on the left side with 'tag-like' excrescenses from a glassy transparent test.

SEASONAL VARIATIONS: Only occasional specimens have been taken from the Peel Island Stations during September and December. It is possible that the species settled in the area between June and September and grew to 4 cm in that time; however, in view of its sparse distribution it may be present throughout the year and have a slower growth rate.

Agnesia glaciata Michaelsen

Agnesia glaciata Michaelsen, 1898, p. 370. Kott, 1969a, p. 450 and synonymy. Monniot, 1970, p. 341.

RECORDS: From the Antarctic Peninsular, South Shetland Islands, the Patagonian Shelf and Kerguelen; California, South Africa, Japan and New Zealand.

DESCRIPTION: (See Kott, 1969a). The specimens are small, laterally flattened and sand-covered. They lie on the left side and the sandy thickened test along the right side of the apertures often overlies the less conspicuous lip on the left.

SEASONAL VARIATIONS: Specimens ranging from 0·05 to 1·5 cm were present in September 1970 and 1971, but in December only a single specimen of 1·0 cm was present. Individuals of 0·8 cm had eggs and sperm in the gonoducts in September in both 1970 and 1971. The species therefore apparently settled sometime between March and September 1970 and rapidly reached sexual maturity. In September 1971 the species was especially common in Area III.

Adagnesia opaca Kott

Adagnesia opaca Kott, 1963, p. 76; 1969a, p. 454.

RECORDS: Port Hacking (New South Wales), Moreton Bay.

DESCRIPTION: (See Kott, 1963, 1969a). Specimens up to 6 cm in greatest diameter are available. There is some variation in the extent to which the folds of test protecting the apertures are produced into flap-like lips and these are not apparent in very small specimens where the branchial aperture is terminal and the atrial aperture antero-dorsal. Lips cover the atrial aperture from below and the branchial aperture from above. The species is sometimes found with specimens of *Molgula sabulosa*.

SEASONAL VARIATIONS: As with *Ascidia sydneyensis* the species was absent in March and June 1970. In September 1970 individuals from 1·5 to 6·0 cm were taken and a single specimen of 5 cm was taken in December 1970. The species was absent in March 1971. In June 1971 specimens from 2·0 to 3·0 cm were taken and in September 1971 specimens from 1·0 to 6·0 cm were taken. There is no great increase in the number of specimens present however and it does not appear that the resident population contributes to the juveniles which settle between June and September. The species appears to grow at a minimum rate of 3 cm in a 3 month period.

Botrylloides nigrum Herdman

Botrylloides nigrum Herdman, 1886, p. 50. Kott, 1972b, p. 30 and synonymy.

RECORDS: (See Kott, 1972b).

DESCRIPTION: (See Kott, 1972b).

SEASONAL VARIATIONS: A single irregularly lobed colony only was taken from Area II in September 1970. It is not likely to be a regular component of the bottom fauna since it is a fixed species and requires either weed or firm substrate to adhere to. The present specimen was probably washed into the area.

Cnemidocarpa floccosa (Sluiter)

Stye a floccosa Sluiter, 1904, p. 64.

RECORDS: Kei Islands, Arafura Sea, sand and coral.

DESCRIPTION: Specimens are more or less crescent shaped with the dorsal border concave, and the ventral border longer and convex. The shape of the body is obscured by the very thick (up to 0·5 cm) coating of sand, mud and shells adhering to the long tough fibrous extensions rising from the ends of short thick protuberances all over the surface of the test. The test itself is very tough. The terminal branchial siphon is long projecting through the thick layer of sand and mud. The atrial siphon is about one-third the length of the branchial siphon and extends straight up from the posterior end of the dorsal border. The fibrous extensions of the test to which the sand and mud adhere also adhere to other specimens to form aggregates with other individuals of the same or different species.

The body wall is not especially muscular. There is a slightly convoluted opening on the large dorsal tubercle at the base of an elongated peritubercular area. The dorsal lamina is narrow and plain edged. The longitudinal vessels are arranged as follows: DL 1(16) 3(16) 3(16) 3(15) 3E.

The gut forms a simple narrow loop across the posterior end of the body and encloses a long narrow flat-topped endocarp in the loop. The anal border is plain. Anterior to the gut loop there are 8 very long narrow cnemidocarp gonads extending from the antero-ventral border of the body and converging to the base of the atrial siphon. There are 14 similar gonads on the right side of the body completely occupying the inner body wall.

REMARKS: Sluiter's specimens only had 5 long narrow gonads on each side of the body. They were, however, identical with the present species in every other way. The shape of the body, position of the atrial aperture and the simple gut loop and the fibrous extensions from the test distinguished the species.

SEASONAL VARIATIONS: The species was absent in March 1970 and March 1971. In June 1970, juveniles of 0·5 and 1·0 cm were present together with a specimen of 5 cm. The individuals taken in September, December 1970 ranged from 1 to 5 cm and it is clear that juveniles were settling in the area continuously through the months from late March or early April to December. The species was again taken in June and September 1971. If the largest specimen present in June 1970 represents a relict population from the previous year that was not sampled in March, the species appears to grow at a rate of about 3 cm during a 3 month period. The number of specimens present in the population does not markedly increase at any time and reproduction does not appear to have taken place.

Styela plicata (Lesueur)

Ascidia plicata Lesueur, 1823, p. 5.
Styela plicata; Kott, 1952, p. 216 and synonymy.

RECORDS: Cape Jaubert, Shark Bay (Western Australia); Port Jackson (New South Wales); Moreton Bay, Hervey Bay (Queensland); Japan; Indonesia.

DESCRIPTION: As previously described: oval, upright with sessile apertures and a soft to leathery, white, longitudinally furrowed test. There are up to 8 internal longitudinal vessels between the branchial folds and up to 30 on the folds. The stomach is long and voluminous with longitudinal folds. The gut forms a narrow vertical primary loop. The rectum extends anteriorly to form a deep secondary loop. The anus has about 15 deep lobes. There are two styelid gonads on each side of the body. The posterior gonad on the left side extends down into the secondary gut loop.

SEASONAL VARIATIONS: This species has been known as one of the more common species in Port Jackson, Moreton Bay and other locations including the Swan River estuary in Western Australia (Kott, 1952), and appeared to tolerate greater fluctuations in salinity than many others. It is not common in the present survey, however, and was taken only in small numbers in September 1970 and June 1971. The specimens taken in September 1970 ranged from 1·5 to 2 cm and probably settled in late June; while in June 1971 specimens ranged from 0·5 to 2·5 cm, and probably settled over the period from late March to June. The species was not taken from Area I. It does not appear to be present for long enough to reach sexual maturity, nor in sufficient density for sexual reproduction.

Styela stolonifera Herdman

Styela stolonifera Herdman, 1899, p. 42. Kott, 1966, p. 298 and synonymy.

RECORDS: (See Kott, 1966). Present records indicate a discontinuous distribution and the species may possibly have been overlooked at other locations.

DESCRIPTION: Characteristic appearance, with both apertures on almost parallel siphons projecting upwards from the anterior surface. The body expands into a rounded postero-dorsal swelling and is supported on a short stalk or 2 to 3 short thick roots. The test is leathery, whitish, and naked and longitudinally furrowed. The dorsal tubercle has a U-shaped slit with horns rolled in. The body wall is very thin and closely adherent to the test. There is an outer circular layer of muscles and inner longitudinal bands. There are 10 to 12 internal longitudinal vessels on deeply curved folds and 2 to 3 between. The gut loop is long, rather narrow, and only slightly curved with the proximal limb extending postero-ventral to the branchial sac. There are 4 to 5 tall almost foliaceous endocarps enclosed in the pole of the loop. Endocarps are also present all over the body wall. The large stomach is long with longitudinal folds which are apparent externally. The anal border has shallow rounded lobes. There are two long branched gonads on the left and 3 on the right.

REMARKS: The rounded swollen postero-dorsal aspect of the body is similar to the condition found in *Styela pedata*, although the species are distinguished by the form of the opening of the dorsal tubercle. It is also closely related to *Styela ramificata* but is distinguished by the well spaced internal longitudinal vessels on the deeply curved folds which accommodate to the greatly shortened dorsal border, the closely placed apertures on the upper surface and the considerable lengthening of the dorso-ventral axis of the body, The long narrow simple gut loop also accommodates to this lengthening of the body and differs from that of *S. ramificata* which forms a shorter loop and in which the rectum

extends anteriorly to form a secondary loop. Externally the stomach folds of *S. ramificata* are obscured by the typhlosolar fold and a thickened membrane covering the gut.

SEASONAL VARIATIONS: The species was absent only in June 1971. Juveniles of less than 1·0 cm were taken in June 1970 and September 1971. In 1970 specimens of maximum size (3·5 and 4·5 cm) were taken in December. Although gonads are developed when the individuals are over 2 cm, no juveniles appeared until the following September (1971). These populations, therefore, do not appear to be producing offspring which settle in the area. Although its apparent growth rate of about 1 cm per month is similar to that of other species sampled, it is one of the few that does not reach sexual maturity until it is relatively large, and it is possible that some seasonal incident terminates its present in the area before sexual reproduction can take place. Alternatively, these sparse populations, probably peripheral to more dense and reproducing populations in an adjacent area, may not reach the necessary density to effect sexual reproduction.

Styela ramificata Kott

(Fig. 7)

Styela ramificata Kott, 1952, p. 214; 1972a, in press, and synonymy.

RECORDS: Moreton Bay, Townsville, Gulf of Carpentaria.

DESCRIPTION: The specimens are large and sandy with the apertures close together on the upper surface. The test is covered with stout projections with long terminal branching hairs that entangle the sand and mud. These are not present in small specimens. There is a bluish colour lining the outer parts of the siphons. The dorsal tubercle is large and prominent and has a U-shaped slit with both horns turned in. The branchial folds are low and wide basally but converge to a sharp rim. There are 30 internal longitudinal vessels crowded on the folds and 9 between. There is an almost vertical narrow gut loop enclosing 2 to 4 tall foliaceous endocarps in the pole. The oesophagus is especially long. The stomach is long with a pronounced typhlosolar fold along its mesial aspect where it projects into the lumen. The outer concavity of this fold is filled with a thickening of the membrane over the gut. There are also long glandular folds in the stomach but these are apparent only from inside the stomach. There is a very small pyloric caecum and a gastro-intestinal connective from the pyloric end of the stomach. The rectum forms a secondary gut loop and terminates in an anus with the border divided into 14 shallow rounded lobes. There are long branching gonads similar to those of *S. stolonifera* crowded on both sides of the body (see Kott, 1952), with testis follicles along both sides of the ovary.

REMARKS: The hairs on the test and the sandy coating are reminiscent of *Cnemidocarpa floccosa* but the species is distinguished by its characteristic gut with an internal typhlosolar fold, and by the form and orientation of the gonads which are more crowded than those of *Styela stolonifera*.

SEASONAL VARIATIONS: Individuals present increase in size from March to December 1970, although no juveniles have been taken after June, and the samples taken do not suggest a reproducing population. The situation appears to be similar to that demonstrated

by the *Styela stolonifera* population in this location which appears to be marginal to more densely populated centres from which enlistment takes place. The species has not been taken from Area I.

Polycarpa tinctor (Quoy and Gaimard)

Ascidia tinctor Quoy and Gaimard, 1834, p. 608. Millar, 1962, p. 399. Kott, 1964, p. 134 and synonymy.

RECORDS: Northwestern and northeastern Australia, Indonesia, Japan.

DESCRIPTION: (See Kott, 1964). There are small protruberances of the test around the meridian which support hair like extensions that probably help in keeping the individual in place on the sandy bottom.

SEASONAL VARIATION: This is one of the most common species sampled and is present throughout the year. It was taken only in small numbers in March 1970. The numbers increased to a peak in September, were slightly reduced in December, and in March and June 1971 were again only rare components of the fauna sampled. Juveniles begin to settle in the area before June, and continue to settle until September. Thereafter there is some mortality of the older members of the population which begins to increase with the onset of reproduction and the addition of juveniles to the populations in June–September. Millar (1962) has observed that the species is anural and viviparous and that the incubation period within the parental peribranchial cavity is of several weeks duration. There is therefore probably little migration from adjacent areas and the populations are self-perpetuating in the area under consideration.

Polycarpa fungiformis Herdman

Polycarpa fungiformis Herdman, 1899, p. 43. Kott, 1964, p. 137 and synonymy.

RECORDS: Moreton Bay, Great Barrier Reef (off Port Douglas).

DESCRIPTION: The specimens are uniformly black and fungiform, with short narrow stalk and large oval body slightly dorso-ventrally flattened with the sessile aperture close together on the upper surface. The outer surface of the test is transversely wrinkled. Juvenile specimens, up to 2·0 cm, are more or less vertical with the stalk from the posterior end of the body. In these specimens the test is less leathery, often gelatinous, semi-transparent, and in the smaller specimens is produced into long hairs to which sand and shell particles adhere. The body wall is always closely adherent to the test. The dorsal tubercle is large and completely fills the triangular peritubercular area. The tubercle, even in the smallest specimens has a porous spongy appearance caused by its many openings. The branchial folds are rounded with about 15 thick internal longitudinal vessels crowded on them but only one between the folds. The branchial sac is especially tough. The gut forms a simple rounded loop enclosing a round to comma shaped flat-topped endocarp. The rectum extends anteriorly almost parallel to the gut loop and ends in a lobed anus. The polycarps are upright and tapered at the base and at their free end.

REMARKS: Internally the species resembles *Polycarpa pedunculata* in its tough branchial sac and the gut with its enclosed endocarp. The distinctive form of the dorsal tubercle is

maintained even in very small specimens. In the smaller juvenile specimens the black colour characteristic of the species is less intense, and sometimes is present only in flecks in the test.

SEASONAL VARIATIONS: There is a population of large individuals of more than 3·0 cm present throughout the year, especially frequent in Area II, and present in greatest numbers during December 1970. Juveniles from 0·3 to 1·0 cm were taken in June 1970, and from 1·0 to 2·0 cm in September 1970. It appears therefore that spawning took place between March and June 1970 and that the juveniles grew to sizes greater than 2·0 cm by December. The numbers of adults taken were very much reduced in March 1971 when there appears to have been some mortality, possibly of older members of the population and in June 1971 juveniles are again present. The species therefore appears to be present as a reproducing population, producing a single generation each year. Although the life span of each individual is not known the population level is maintained by the addition of the developing juveniles and a corresponding annual mortality, possibly of adults over a year old.

Polycarpa pedunculata Heller

Polycarpa pedunculata Heller, 1878, p. 106. Kott, 1972b, p. 35 and synonymy.

RECORDS: (See Kott, 1972b).

DESCRIPTION: The specimens from this location do not show the polymorphism described from St Vincent Gulf (Kott, 1972b). They are a pale creamish colour in preservative. The test is tough and without sand or shell adhering. The body is oval with a terminal sessile branchial aperture and a sessile atrial aperture halfway along the dorsal surface. The short stalk is produced from the postero-ventral aspect of the body. The body wall is muscular with the usual vesicular cells interrupting the fibres. The branchial sac is tough with low rounded folds. The dorsal tubercle has a U-shaped slit with both horns usually turned out. The gut encloses the usual circular endocarp.

REMARKS: The species is often similar in shape to *Polycarpa fungiformis* and the gut loop is identical and encloses a large flat-topped endocarp. The dorsal tubercle is the only character which can be used to distinguish immature specimens of these species, when neither the gonads nor the black pigmentation of *P. fungiformis* are developed.

SEASONAL VARIATIONS: The species is not a very common component of the fauna of this area. Only a single juvenile was taken in September 1970 when adults of 6 and 7 cm respectively were also present. Individuals of 2·75 and 3·5 cm were taken in December; a single individual of 2·5 cm was taken in March 1971; 4 individuals of 4·0 to 4·25 cm were taken in June 1971. It appears therefore that occasional individuals are enlisted from a breeding population outside the area from September to December, grow to about 3 cm in three months and reach their maximum size of about 7 cm within 12 months. The species does not, however, reach a sufficient density to form a breeding population in the area sampled.

Pyura vittata (Stimpson)

Cynthia vittata Stimpson, 1852, p. 230.
Pyura vittata: Kott, 1972b, p. 37 and synonymy.

RECORDS: (See Kott, 1972b).

DESCRIPTION: The body is an irregular inverted pyramid with the branchial aperture on the outer rim of the upper surface surrounded by conspicuous black and white stripes. The opposite side of the upper surface conceals 3 large lamellibranch molluscs within the test. Similar black and white stripes surround the sessile atrial aperture which is half way along the upper surface. These conspicuous stripes that surround the apertures are continuous with the inner siphonal linings and are covered with the needle like spines characteristic of the species. In the single specimen taken during the course of this survey these black and white stripes interrupt the otherwise sandy surface on a strip between the atrial aperture and the area of test in which the lamellibranchs are embedded. It has probably resulted with growth and healing of the test following entry of the lamellibranchs.

SEASONAL VARIATION: Only a single large specimen was taken in March 1970. The species is very often taken from the sea floor but is not free living and on the sandy substrate available at this location there are no suitable rocks, shells etc. to provide a suitable surface for attachment.

Microcosmus spinifera (Herdman)

Cynthia spinifera Herdman, 1899, p. 32.
Microscomus spinifera; Kott, 1952, p. 286.

RECORDS: (See Kott, 1952).

DESCRIPTION: (See Kott, 1952). Individuals have short stalks or root-like processes or are sessile on scallop shells. The surface test on the rest of the body is produced into the usual pointed spines which are especially thick and long around the apertures. There are 6 high overlapping folds on both sides of the body. The gonads are long and continuous. The left gonad crosses the descending limb of the gut loop into the pole of the gut loop.

SEASONAL VARIATIONS: Specimens were taken in June and September in 1970 and 1971. It is not a very frequent component of the fauna and there is no indication that a reproducing population is set up.

Microcosmus exasperatus Heller

(Fig. 8)

Microcosmus exasperatus Heller, 1878, p. 99.
Microcosmus clandicans sub sp. *exasperatus*; Michaelsen and Hartmeyer, 1928, p. 403 and synonymy.

RECORDS: (See Michaelsen and Hartmeyer, 1928).

DESCRIPTION: Only 2 individuals were taken, one attached to a shell by a widely spread flat base, the other rounded, posteriorly. Both apertures are fairly close together and are on short siphons directed away from one another. The test is tough, leathery and whitish and is produced into lobes around the apertures. The slit on the dorsal tubercle is U-shaped with both horns unrolled. There is a tricuspid valve formed by folds of the siphonal lining at the base of the branchial siphon. Pointed spines 0·05 mm long line the siphons. In the

juvenile specimen of 0·6 cm diameter there are 7 branchial folds but the specimen of 3 cm diameter has 9 folds on each side of the body with 1 to 2 internal longitudinal vessels between and 18 to 20 on the folds. The gut forms a deeply curved narrow loop. The gonads are subdivided into 3, the most proximal division crossing into the pole of the gut loop on the left. The liver is composed of groups of parallel lamellae.

SEASONAL VARIATIONS: Only two specimens were taken, a juvenile in June 1970 and a specimen of 3 cm in December. The species does not set up a breeding population in this location and its occurrence is clearly the result of enlistment from elsewhere in the Bay.

Microcosmus australis Herdman

(Fig. 9)

Microcosmus australis Herdman, 1899, p. 23. Kott, 1972a, in press, and synonymy.

RECORDS: (See Kott, 1971).

DESCRIPTION: The test is tough, leathery, wrinkled and whitish. The dorsal tubercle is U-shaped with both horns rolled in. There are 7 branchial folds on each side of the body. The gonads and gut are of the usual form. Small pointed spines 0·02 to 0·03 cm are present lining the siphons.

REMARKS: This species resembles *M. exasperatus* in every aspect except the size of the spines lining the siphons.

SEASONAL VARIATION: Only a single specimen was taken, in December 1970. Since it was 2 cm in diameter it is probable that it settled sometime between September and December from an adjacent breeding population.

Microcosmus stolonifera Kott

Microcosmus stolonifera Kott, 1952, p. 291; 1972b, p. 43 and synonymy.

RECORDS: Spencer Gulf, St Vincent Gulf, Tasmania, Westernport.

DESCRIPTION: Posteriorly the two specimens of this species that were taken are produced into roots with adhering sand. The siphons are anterior and fairly close together but the thickening of test around the siphons is not developed. There are 7 branchial folds on each side of the body. The gut loop is very narrow. The gonads are rounded and the left gonad is in the curve of the gut loop and does not extend over into the primary loop.

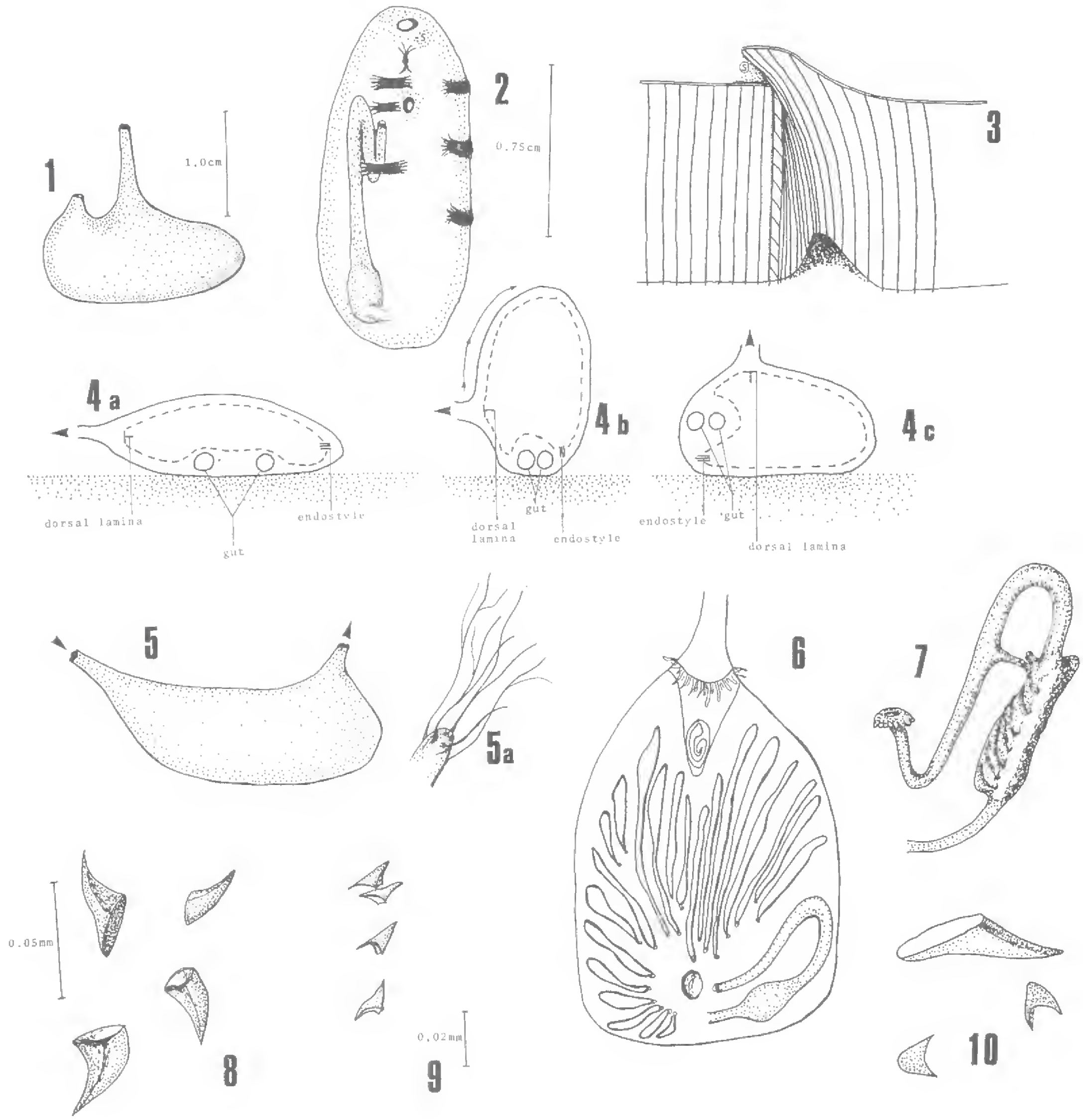
SEASONAL VARIATION: Only two specimens of 2 cm were taken in June 1970.

Microcosmus nichollsi Kott

(Fig. 10)

Microcosmus nichollsi Kott, 1952, p. 290; 1972b, p. 42 and synonymy.

RECORDS: St Vincent Gulf, Westernport, and Victoria.



FIGS. 1–4: *Ascidia aclara*. 1, Individual. 2, Individual removed from test viewed from above showing muscle bands, gut loop and dorsal ganglion. 3, Diagram of antero-dorsal portion of the branchial sac showing the origin of the branchial fold from the prebranchial area anterior to the dorsal tubercle. 4, Diagrammatic transverse sections showing possible evolution of *A. aclara*—a, laterally flattened, free living ancestral form; b, shortening of left side of the body altering stability; c, stable dorso-ventrally flattened *A. aclara*.

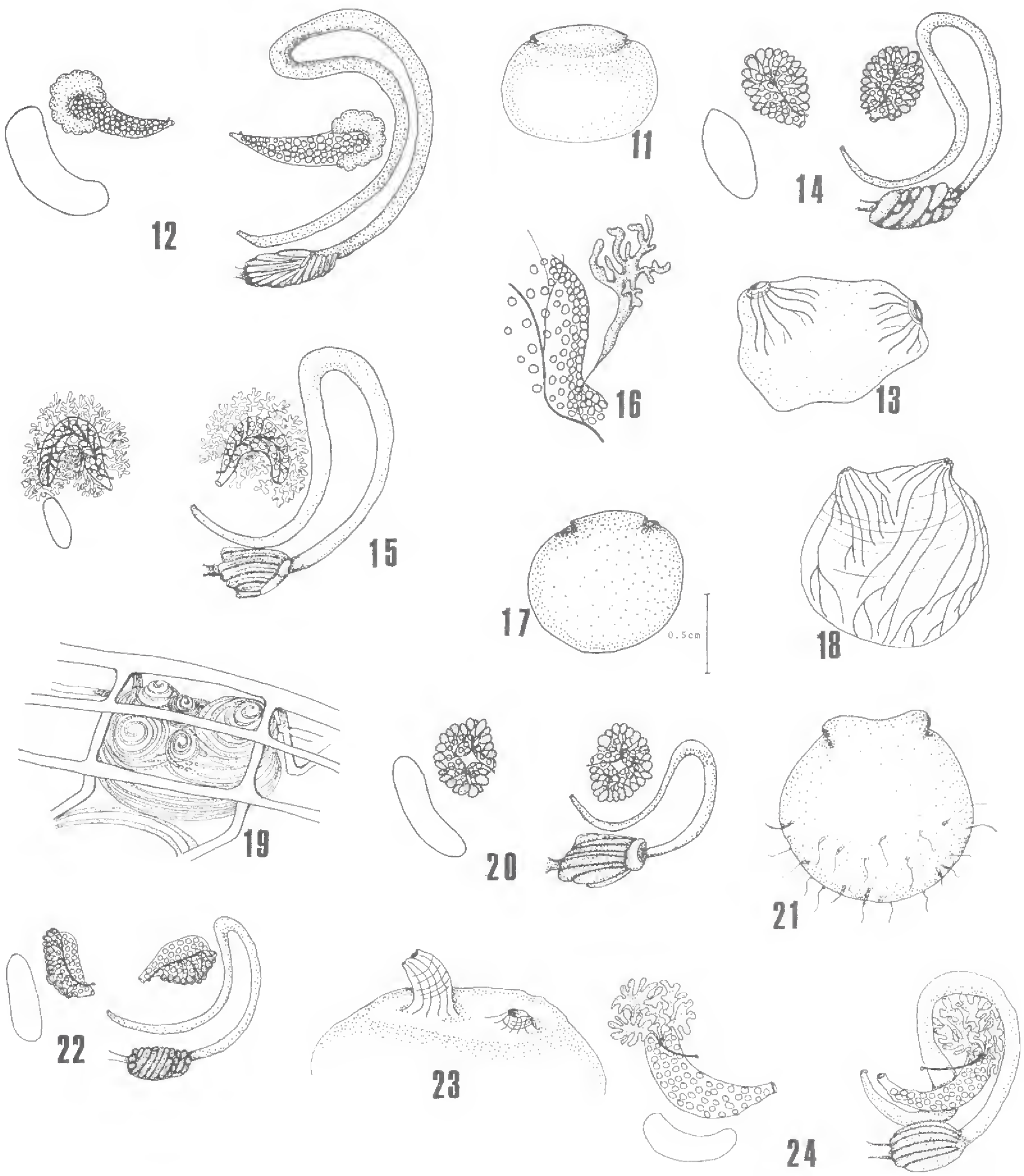
FIGS. 5, 6: *Cnemidocarpa floccosa*. 5, Individual removed from test. 5a, Test hair of *C. floccosa*. 6, Individual opened round ventral surface; branchial sac removed to show gonads and gut.

FIG. 7: *Styela ramificata*. Gut loop showing typhlosolar groove in stomach wall.

FIG. 8: *Microcosmus exasperatus*. Branchial spines.

FIG. 9: *Microcosmus australis*. Branchial spines.

FIG. 10: *Microcosmus nichollsi*. Branchial spines.



FIGS. 11, 12: *Molgula sabulosa*. 11, Whole individual. 12, Kidney, gut loop and gonads on inner body wall.
FIGS. 13, 14: *Molgula exigua*. 13, Individual removed from test. 14, Kidney, gonads and gut loop on inner body wall.
FIGS. 15, 16: *Molgula rima*. 15, Kidney, gonads and gut loop on inner body wall. 16, Single testis follicle and portion of the ovary and vas deferens.
FIGS. 17–20: *Molgula sphaera*. 17, Whole individual. 18, Individual removed from test. 19, Portion of branchial sac showing sub-divided infundibulum. 20, Kidney, gonads and gut loop on inner body wall.
FIGS. 21, 22: *Molgula diversa*. 21, Whole individual. 22, Kidney, gonads and gut loop on inner body wall.
FIGS. 23, 24: *Eugyra moretonensis*. 23, Anterior portion of individual showing branchial and atrial apertures. 24, Kidney, gonads and gut loop on inner body wall.

DESCRIPTION: Only a single specimen was taken. It is spherical, with the apertures close together on the upper surface. In contrast to other species of *Microcosmus* taken in this survey, the test is thin and rigid with sand, rather than tough and leathery. There are 7 branchial folds on each side of the body with about 10 internal longitudinal vessels on the folds and 1 to 2 between. The left gonad extends into the pole of the gut loop but is very immature. There are small scales lining the siphons with long, pointed spines more sparsely distributed amongst these.

SEASONAL VARIATION: The single juvenile specimen was taken in September 1970.

Molgula sabulosa (Quoy and Gaimard)

(Figs. 11, 12)

Ascidia sabulosa Quoy and Gaimard, 1834, p. 613. Michaelsen and Hartmeyer, 1928, p. 449 and synonymy. Kott, 1952, p. 298 (part). Millar, 1966, p. 374.

[?] *Molgula mollis* Herdman, 1899, p. 54. Kott, 1972b, p. 45 and synonymy.

RECORDS: Indonesia and circum-Australia.

DESCRIPTION: The species is common and forms large aggregates of individuals. They are laterally flattened and circular in outline. The test is usually rigid with sand. Both apertures are close together anteriorly on very short siphons directed away from one another and sometimes depressed into the upper surface. There is a ridge of test extending along between both apertures accentuating their orientation away from one another. The test around the apertures may be thickened into a rounded rim. The dorsal lamina is very short and the branchial folds are deeply curved. There are 7 branchial folds on each side of the body with 7 to 11 internal longitudinal vessels on each fold but none between. There are a large number of infundibula along each branchial fold and these subdivide on the summit of the fold. The internal longitudinal vessels and the transverse vessels tend to subdivide and anastomose at the base of the folds and in the interspace especially dorsally. The infundibula also subdivide and form interstitial coils. The gut forms a narrow curved loop and there is a narrow curved kidney on the right. The gonads consist of an elongate ovary with a semicircle of testis follicles around the proximal end. On the left the gonad extends out of the secondary gut loop toward the atrial aperture. On the right the gonad extends anterior to and at an angle to the length of the kidney, diverging toward the atrial aperture. In specimens of 0·5 cm and less the gonads are not developed.

REMARKS: The relationships between this species and *Molgula mollis* are not clear. The branchial sac differs only in the reduced number of internal longitudinal vessels (which varies with size in the present specimens); the gonads, kidney and gut are identical in the two species; and differences in external appearance could well be associated with the size of the individuals. *Molgula sabulosa* has been recorded from a wide range of localities. *Molgula mollis* has been recorded from New South Wales, Queensland and South Australia and could well represent young specimens of the present species.

SEASONAL VARIATION: The species is one of the most common components of the fauna at this location and is found in large aggregates, often with *Styela ramificata*. The species appears to occur annually. There was only a single specimen taken in March 1970

and it was completely absent from the hauls in March 1971. It was absent in June 1970 and 1971. It was present in September of both years. In December 1971 it was especially common and ranged in size from 0·5 cm to 3 cm. Thus the species apparently settles, especially in the Areas II and III, from late August or early September. Gonads appear well developed in specimens of 2 cm or more and since enlistment in December 1970 occurred at an increased rate, it is probable that maturing individuals are reproducing to contribute juveniles to the population at that time. The species is, therefore, probably present in sufficient density to reproduce sexually. The absence of the species during June 1970 and March–June 1971 may be caused by some physical factor (such as flooding). Populations thus are not self-perpetuating and initial enlistment must be from some region outside the area surveyed that is not exposed to this seasonal factor.

Molgula exigua sp. nov.

(Figs. 13, 14)

HOLOTYPE: ½ mile S. of Southwest Rocks, Moreton B., sand shell and grit, 7·7 m, June 1971, QM G6322.

PARATYPES: ½ mile SE. of Southwest Rocks, Moreton B., mud, 5 m, 1 spem., QM G6020. ½ mile S. of Southwest Rocks, Moreton B., sand shell and grit, 7–10 m, 29 spems., QM G5999, G6007–19, G6021–2, G6323. 1 mile S. of Southwest Rocks, Moreton B., sandy mud, 2·5–6 m, 32 spems., QM G5990, G5993–8, G6000–6.

DESCRIPTION: Individuals are small and rounded and relatively firm. There are sand particles adhering over the whole of the body attached to the test and to hair-like extensions of the test. These are larger around the siphons. The apertures are sessile and far apart, almost at opposite ends of the body. There is a broad velum in the base of both very short siphons with only a small aperture in the centre of each. The dorsal lamina is long, about three-quarters of the maximum length of the branchial sac. There are 6 rows of 6 coiled infundibula, each projecting only slightly, with 1 to 3 internal longitudinal vessels close together along the centre of each row above the apices of the infundibula. There is a seventh row of infundibula dorsally, on each side of the dorsal lamina, that is not crossed by internal longitudinal vessels. There are some interstitial stigmatal coils. The infundibula subdivide into 2 in the most ventral row.

The gut forms a narrow curved loop and the kidney is short and oval and not curved. The gonads consist of a short flask-shaped ovary with the short oviduct directed toward the atrial aperture, and completely surrounded by testis follicles which sometimes encroach onto the mesial surface of the ovary. The vasa efferentia join on the mesial surface of the ovary and form a median vas deferens opening at the base of the oviduct. The right gonad is dorsal to and almost parallel to the kidney directed posteriorly to the atrial aperture; the left gonad extends from just inside the pole of the gut loop toward the atrial aperture.

REMARKS: The rather stiff test with slightly larger sand grains adhering, the widely separated apertures, the almost flat undivided infundibula, the large siphonal vela, and the shape and orientation of the gonads are all characteristic of this species.

SEASONAL VARIATIONS: The species was taken in sizes ranging from 0·3 to 1·0 cm in all months except March 1970 and 1971. There appears to be some mortality of larger

specimens from December although smaller specimens are still present. Gonads are mature in individuals of 0·5 cm and these probably contribute juveniles to the population. The larger adults appear to die off from December, and although some smaller individuals persist these had also disappeared in March. Therefore, it appears that individuals of this species have a life span of less than 12 months, and that for the greater part of this period they are reproducing. Resettlement in the succeeding year is probably from a persisting population in an adjacent area.

Molgula rima sp. nov.

(Figs. 15, 16)

HOLOTYPE: ½ mile S. of Southwest Rocks, Moreton B., sand shell and grit, 7·7 m, June 1971, QM G6324.

PARATYPES: ½ mile S. of Southwest Rocks, Moreton B., sand shell and grit, 7–10 m, 21 spems., QM G6023–8, G6030–6, G6325–7. 1 mile S. of Southwest Rocks, Moreton B., sandy mud, 3·5–6 m, 27 spems., QM G6037–44.

DESCRIPTION: Each individual is small and oval, laterally flattened and covered with a very thick coating of fine sand and mud that is held in place by very long hair-like processes from the surface of the very thin transparent test. The coating of sand and mud may be scraped away to expose both rather long siphons, about one-third of the body length apart, projecting from the upper surface and long enough to open level with the outer surface of the thick sandy coating. There are strong muscles around both siphons and in short parallel bands around either side of the dorsal and ventral borders of the body. There are only very narrow siphonal vela at the base of both the atrial and branchial siphons. The dorsal lamina is about three-quarters of the length of the branchial sac. There are 6 rows of 8 tall narrow conical infundibula in each row, sometimes subdivided into two apices only at the top of each cone. There are 10 internal longitudinal vessels extending along both sides of the rows of infundibula. The gut loop is long and curved, open at the pole. There are long parallel liver lamellae. The kidney is oval and curved. The gonads are deeply curved and consist of a central ovarian tube fringed on both sides by long and much branched testis follicles spreading out onto the body wall around the ovary. The testis follicles are not always continuous all around the ovary, but may be absent for part of its length on either side. The right gonad extends anteriorly from the anterior end of the kidney and then curves in a deep 'U' before bending dorsally to open near the base of the atrial aperture. The left gonad extends anteriorly from the concavity of the secondary gut loop and then makes a similar curve posteriorly and dorsally. Vasa efferentia run across the mesial surface of the ovary to join the vas deferens which opens before the ovary curves dorsally toward the atrial aperture.

REMARKS: This interstitial species is very similar to *Molgula habaensis* Van Name. 1945 but differs in the orientation of the gonads. It may be distinguished from the other interstitial species in the present collection by the tall narrow infundibula projecting into the folds, by the absence of an extra row of infundibula, by the long test hairs, thick sand coating and protruberant siphons, by narrow siphonal vela and by the long curved ovaries and the long and branched testis follicle spreading over the body wall around the ovary,

SEASONAL VARIATION: The species was present, mostly in Area II, but also in Area III from June until September, but was absent from samples in March and December 1970 and March 1971. The individuals appear to have a short life span of less than 6 months. The gonads appear to be mature at a very early stage and eggs were present in the peribranchial cavity of specimens of 1·5 cm taken in September. There is a rapid increase in the size of the population present in September 1971 and it is probable that this increase is the result of reproduction by the resident population. The species does not apparently persist in the area to initiate the populations in the succeeding year. The species, therefore, behaves in the area as does *Molgula exigua.*

Molgula sphaera sp. nov.

(Figs. 17–20)

HOLOTYPE: ½ mile S. of Southwest Rocks, Moreton B., sand shell and grit, 8·2 m, Sept. 1970, QM G6319.

PARATYPES: ½ mile SE. of Southwest Rocks, Moreton B., mud, 7·2 m, 3 spems., QM G6082, G6318; ½ mile S. of Southwest Rocks, Moreton B., sand shell and grit, 7 m, 1 spem., G6317. 1 mile S. of Southwest Rocks, Moreton B., sandy mud, 2·5–3·5 m, 3 spems., QM G6081, G6083–4.

DESCRIPTION: These small sandy individuals are absolutely spherical. The sessile apertures are close together on the upper surface. There are only sparse but long test hairs and the sandy coating is embedded in the superficial layer of test making it very brittle. The body wall is closely adherent to the test. Very fine circular muscle fibres are present over the whole body outside the longitudinal bands that radiate from the siphons and become diffuse over the ventral part of the body. There is a narrow branchial velum but no atrial velum was detected. The dorsal lamina is very short and the oesophagus opens half way down the branchial sac. There are 7 rows of 6 infundibula on each side of the body with 3 to 4 internal longitudinal vessels extending along both sides of each row of infundibula. In the most ventral row there are 12 infundibula. There is no extra dorsal row of infundibula. Each infundibulum is very wide basally and subdivides many times and irregularly on several places in the summit of the folds. The gut loop is long, deeply curved and open at the pole, and the kidney is fairly long and curved. The gonads consist of an almost circular ovary completely surrounded by long branched testis follicles tightly packed. The vasa efferentia join into 3 to 5 main ducts on the surface of the ovary, which open into a voluminous seminal vesicle that narrows to a vas deferens opening at the base of the short oviduct.

REMARKS: The species is characterised by its thin brittle test, its short dorsal lamina and closely placed apertures, by its conical infundibula and their irregular subdivision apically, by the circular gonads and seminal vesicle and by the long curved kidney.

SEASONAL VARIATION: The species is rare and was taken only in June and September 1970 and in September 1971. Larger individuals were taken in September but there was no great increase in their number. There is no indication therefore that the populations are reproducing.

Molgula diversa sp. nov.

(Fig. 21)

HOLOTYPE: ½ mile S. of Southwest Rocks, Moreton B., sand, shell and grit, 7·7 m, June 1970, QM G6320.

PARATYPES: ½ mile S. of Southwest Rocks, Moreton B., sand, shell and grit, 8·5–10 m, 2 spems., QM G5992, G6321. 1 mile S. of Southwest Rocks, Moreton B., sandy mud, 3·5–6 m, 2 spems., QM G5989, G5991.

DESCRIPTION: Small specimens covered with a thin coating of sand and mud. There are some relatively sparse short test hairs around the posterior surface of the body. The apertures are on very short siphons, close together on the dorsal surface and directed away from one another. There are wide atrial and branchial vela at the base of the siphons. The dorsal lamina is very short and the oesophagus opens about half way down the branchial sac. There are 7 rows of 7 tall conical infundibula that are subdivided for most of their extent so that double that number is present and the primary 7 in each row is evident only at the base of the cone in the interspace between the folds. There are 3 to 5 internal longitudinal vessels along both sides of the rows of infundibula. The gut forms the usual curved loop and the kidney is straight and elliptical. The gonads consist of flask-shaped ovaries with testis follicle only along the postero-ventral side of the ovary. On the right the gonad is dorsal and almost parallel to the kidney but diverging slightly distally toward the atrial aperture. On the left the gonad extends from inside the gut loop postero-dorsally toward the atrial aperture.

REMARKS: The species is characterised by the closely placed and diverging siphons, by the short dorsal lamina and well developed siphonal vela, by the well developed conical infundibula subdivided for the whole of their height so that double the primary number are present in the branchial sac and by the form of the gonads with testis follicles only along one side of the ovary and not spreading out onto the body wall.

SEASONAL VARIATION: The species is rare in the area studied and was taken only during June, September and December 1970 and in September 1971. There is no indication that this population is producing juveniles.

Eugyra moretonensis sp. nov.

(Figs. 23, 24)

HOLOTYPE: ½ mile SE. of Southwest Rocks, Moreton B., mud, 7·2 m, Sept. 1970, QM G6328.

PARATYPES: ½ mile SE. of Southwest Rocks, Moreton B., mud, 5–5·5 m, 6 spems., QM G5965, G5972–3, G6329. ½ mile S. of Southwest Rocks, Moreton B., sand, shell and grit, 7 m, 1 spem., QM G5975. 1 mile S. of Southwest Rocks, Moreton B., sandy mud, 2·5–3·5 m, 21 spems., QM G5961–4, G5966–71, G5974, G5976.

DESCRIPTION: The body is soft and laterally flattened and covered with fine sand and mud which is held in place with long hair-like extensions of the test. The apertures are close together on the upper surface in an area of very soft sand-free test slightly depressed into the upper surface. The atrial siphon when extended is about three times the length of the branchial siphon, which is almost sessile, and is directed away from it. The atrial siphon is,

however, very muscular and contractile, and when withdrawn its soft test falls into gathers around it. There are 7 internal longitudinal vessels in the branchial sac each crossing the centre of a row of 6 infundibula although in the ventral row there are twice that number. There is also an extra row of infundibula dorsally not crossed by a longitudinal vessel. The spirals protrude slightly and are not flat. The gut forms a narrow loop, deeply curved in its proximal part. The anus is smooth rimmed. The kidney is long and curved. The pole of the loop is open. The stomach is short and rectangular with about 10 longitudinal folds. The gonads consist of elongate tubular ovaries opening by a short oviduct directed toward the atrial aperture and with a 'fan' of testis follicles around the proximal end, their ducts joining the vas deferens on the mesial surface of the ovary. The vas deferens is free for most of its length and opens about half way along the length of the ovary. On the right side of the body the gonad is dorsal to and parallel with the kidney; on the left the proximal part of the ovary with its associated testis follicles is accommodated in the loop of the gut, the ovary and vas deferens then crosses over the descending limb of the gut loop and extends dorsally more or less parallel to the rectum. Well-developed tail-less embryos are present in the peribranchial cavity.

REMARKS: This is the first species of this genus described from Australia although in view of its small size this and other species could well have been overlooked. It is characerised by the unusually large number of internal longitudinal vessels, and by the single opening of the vas deferens. The characteristically retractable siphons are identical with those previously described for this genus, although previously the branchial siphon has been regarded as longer than the atrial siphon. The genus is found exclusively on the open sea floor and has been recorded from a wide range of depths and geographical locations from arctic to antarcitc seas. However, no great range in morphology between the different species of the genus has been described.

SEASONAL VARIATION: The species is present in June and in increased numbers in September in both 1970 and 1971. Embryos are present in the peribranchial cavity of specimens of 1 cm collected in September, so the populations are reproducing. Their presence in the area is, however, seasonal, and the initial populations established in June have, presumably, been derived from adjacent areas where the species is able to survive those influences which cause their mortality.

STATION INFORMATION

Area I: Mud, $\frac{1}{2}$ mile SE. of Southwest Rocks, Peel Island, 4·5 to 6 metres.

Area II: Shell, grit and sand, $\frac{1}{2}$ mile S. of Southwest Rocks, Peel Island, 6 to 9 metres.

Area III: Sand, mud and shell, 1 mile S. of Southwest Rocks, Peel Island, 2·5 to 4·5 metres.

Of these, Area I has a consistently poor ascidian fauna, possibly correlated with the mud substrate and the interstitial molgulids are especially affected. Area II has the most consistently diverse and the more densely distributed fauna. Each species, however, is not randomly distributed and most occur grouped together.

Table 1 shows the total numbers of species in 5 samples at 5 locations in each of the areas I to III over the period March 1970 to September 1971.

TABLE 1

OCCURRENCE OF SPECIES AT 5 STATIONS IN AREAS I TO III

Species	1970												1971								
	March			June			September			December			March			June			September		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
FIXED SPECIES																					
P. fungiformis . .	1	5	3	—	18	5	—	21	2	—	17	2	1	5	1	2	7	—	—	2	1
P. pedunculata . .	—	3	—	—	—	—	2	1	—	—	2	1	—	2	—	1	1	3	—	2	3
S. stolonifera . .	—	2	1	3	—	—	—	3	3	—	—	2	2	1	—	—	—	—	—	—	4
A. sydneyensis . .	—	—	—	—	—	—	—	1	—	—	2	—	—	—	—	—	—	—	—	1	1
S. plicata . .	—	—	—	—	—	—	—	1	2	—	—	—	—	—	—	—	5	—	—	—	—
M. spinifera . .	—	—	—	—	—	1	—	3	—	—	—	—	—	—	—	1	1	—	—	1	1
M. exasperatus . .	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
M. stolonifera . .	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
M. nichollsi . .	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
M. australis . .	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
B. nigrum . .	—	—	—	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—	—	—	—
P. vittata	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
S. pedunculata . .	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5	1
FREE-LIVING SPECIES																					
P. tinctor . .	1	1	4	—	11	4	—	11	11	—	14	3	—	—	1	—	3	4	—	2	8
M. sabulosa . .	—	—	1	—	—	—	2	1	1	—	64	35	—	—	—	—	—	—	—	1	25
S. ramificata . .	—	5	2	—	8	1	—	1	—	—	2	—	—	—	—	—	—	—	—	—	1
M. exigua . .	—	—	—	—	15	5	—	22	20	—	1	6	—	—	—	—	2	1	—	5	8
A. aclara	—	—	—	—	2	—	—	3	—	—	1	—	—	—	—	—	2	8	—	5	3
C. floccosa . .	—	—	—	—	1	2	—	1	1	—	2	1	—	—	—	1	—	—	—	—	2
M. rima	—	—	—	—	6	1	—	1	2	—	—	—	—	—	—	—	13	—	—	8	30
E. moretonensis . .	—	—	—	—	1	2	8	—	1	—	—	—	—	—	—	—	—	1	1	1	21
A. glaciata . .	—	—	—	—	—	—	7	—	6	—	1	—	—	—	—	—	—	—	24	—	324
A. opaca . .	—	—	—	—	—	—	—	3	—	—	1	—	—	—	—	—	6	—	—	6	3
M. diversa . .	—	—	—	—	2	—	—	—	2	—	1	1	—	—	—	—	—	—	—	1	2
M. sphaera . .	—	—	—	—	—	1	1	2	1	—	—	—	—	—	—	—	—	—	2	—	2

CHARACTERISTICS OF THE ASCIDIAN FAUNA

Of the twenty-four species comprising the ascidian fauna of this area, a relatively large number (12) are not fixed but lie free on the sea floor. This number includes 5 new species of the family Molgulidae, possibly endemic to Moreton Bay. There are 5 other species which are not endemic but are, nevertheless, unusual in their distribution, having previously been

recorded only from widely separated geographic locations, usually in regions protected from the open ocean. Thus, in addition to the Moreton Bay records, *Ascidia aclara* has been taken from St Vincent Gulf, Port Phillip Bay, Lakes Entrance; *Adagnesia opaca* has been taken only from Port Hacking; *Styela ramificata* only from the Gulf of Carpentaria; *Cnemidocarpa floccosa* is known only from Indonesia; and *Agnesia glaciata* has a cosmopolitan distribution in sheltered locations in the Pacific and southern oceans. These free living species are most often present in greater numbers than the fixed species, and appear to be more successful in this area.

In regions at the mouth of rivers, freshwater flooding, deposition of silt, and temperature fluctuation may cause annual mortality amongst the benthic fauna. The life history of individuals in those populations that are vulnerable to such seasonal events is therefore limited, and the individuals may not grow very large and must reach sexual maturity early. The branchial sac is equally limited in size and cannot accommodate any great increase in its perforated area by the formation of the deep folds that are characteristic of most other species of stolidobranch ascidians. The branchial sac of small individuals, however, will accommodate an increase in the area perforated by cilia-lined stigmata by the formation of spiral infundibula. Therefore, in those locations where seasonal variations cause mortality, and an annual fauna reaching early maturity is favoured, or where small sized individuals are favoured in the interstitial benthic fauna, species of the families Molgulidae and Agnesiidae appear to fulfil the requirements. The free living species in the area surveyed include a significantly high proportion of species of these families. Where seasonal changes in the environment do not occur to cause annual mortality it is probable that individuals of the same species would continue their growth. In this respect the very large size range recorded for *Ascidia aclara*, *Adagnesia opaca* and *Molgula sabulosa* is significant (from 1 cm up to 6 cm in greatest dimension).

The fixed species taken, with the exception only of the stalked *Polycarpa fungiformis*, are known from a wide range around the Australian coast. They do not appear to have any special adaptation for the sea floor in the region surveyed and have only been taken there occasionally. *Polycarpa fungiformis*, however, is present in large numbers and is otherwise known only from a single specimen in the Papuan Channel (Northeast of Cairns, Great Barrier Reef; Hastings, 1931).

ENLISTMENT

Except for those species that persist in the area throughout the year, a population is initiated when larvae, from an area (probably in deeper water further from the river mouth) which has been less influenced by seasonal fluctuations in salinity and temperature, settle as juveniles. The rate of growth for many of the species is relatively rapid and sexual maturity is often reached at an early stage. The juveniles appear in the populations of many of these species throughout the period when it is present and may therefore be the offspring of maturing adults in the resident population. However, in many cases the number of specimens sampled is small and suggests a very low density of individuals, representing populations which do not increase in size and do not appear to be reproducing. Thus the species of ascidian present in the area may also be subdivided into the following groups according to the behaviour of the populations in the area surveyed:

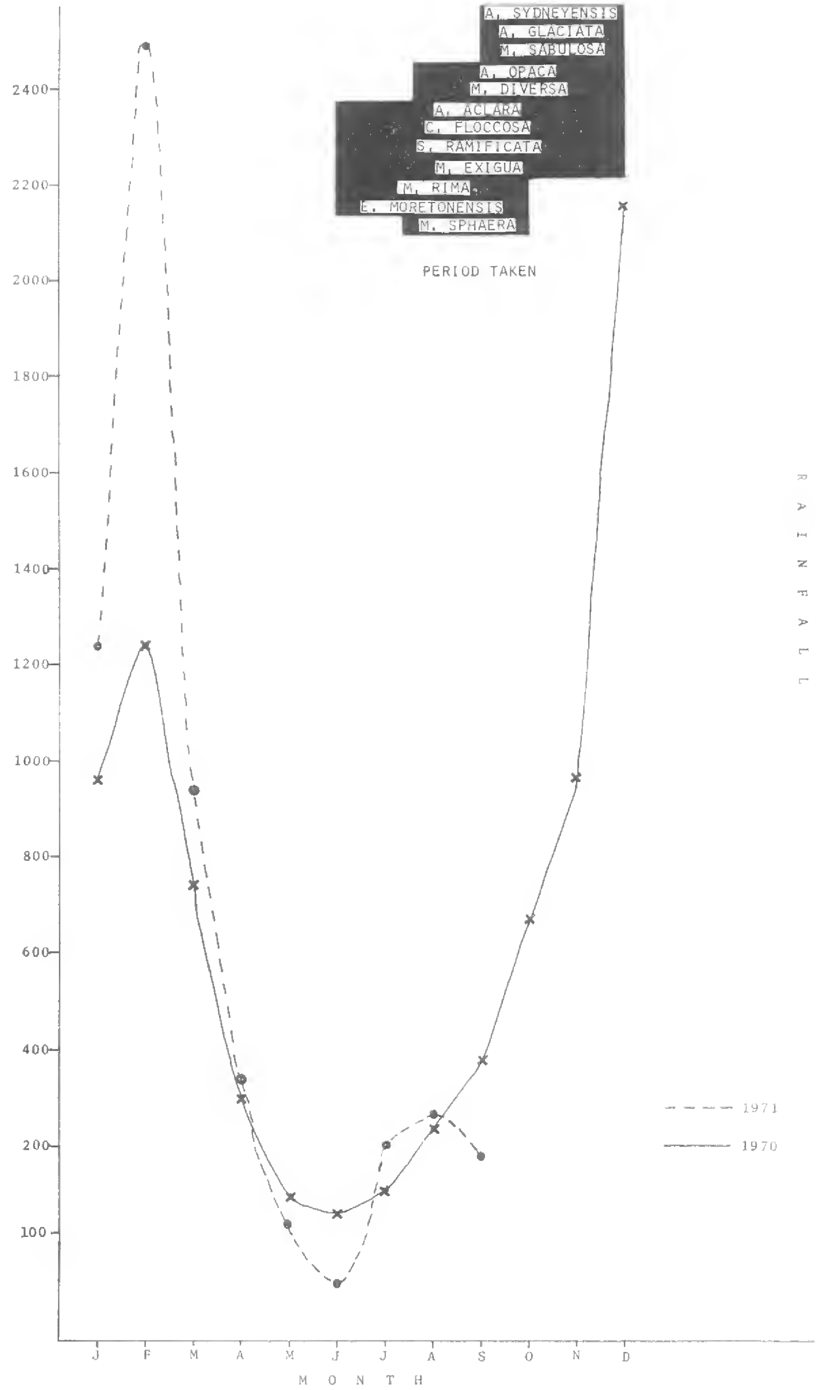


FIG. 25: Average of rainfall recorded at Springbrook and Beaudesert in the Logan and Albert Rivers catchment.

Species Enlisted from other Areas which do not set up Breeding Populations in the Area

These are only rare components of the fauna and absence of sexual reproduction may be due to their sparse distribution preventing effective fertilisation of gonadial products (Kott, 1969). Only *Adagnesia opaca*, *Molgula sphaera* and *M. diversa* are possibly viviparous. The other species involved are most likely to be oviparous, with larvae of fairly long life. Both gonadial products and larvae are thus exposed to wide dispersal which could be the explanation for their sparse distribution. The absence of suitable substrate for these species, which are mostly fixed, may also contribute to their lack of success.

Ascidia sydneyensis
Adagnesia opaca
Botrylloides nigrum
Styela plicata
Styela stolonifera
Styela ramificata
Polycarpa pedunculata
Pyura vittata
Microcosmus spinifera
Microcosmus exasperatus
Microcosmus australis
Microcosmus stolonifera
Microcosmus nichollsi
Molgula sphaera
Molgula diversa

Species Enlisted from other Areas which do set up Breeding Populations but Experience an Annual Mortality Preventing the Establishment of Self-perpetuating Populations

These are frequent seasonal components of the ascidian fauna and appear to be adapted for the substrates available. They are often free living and reach maturity early. Only very occasionally do specimens survive from year to year (e.g. *Cnemidocarpa floccosa*). At least *Eugyra moretonensis*, and probably some of the *Molgula spp.* are viviparous, with short lived larvae not subject to wide dispersal. Settlement is thus effected in sufficient density to ensure that sexual reproduction can take place. Some value, however, must be attached to dispersal for species in areas subject to annual mortality from some seasonal factor.

Ascidia aclara
Agnesia glaciata
Cnemidocarpa floccosa
Molgula sabulosa
Molgula exigua
Molgula rima
Eugyra moretonensis

Species with Persistent Populations present throughout the Year and Reproducing

Polycarpa tinctor is known to be viviparous and anural; thus avoiding dispersal and ensuring populations of sufficient density for sexual reproduction. The species spawns in June to September.

Polycarpa fungiformis spawns in March to June.

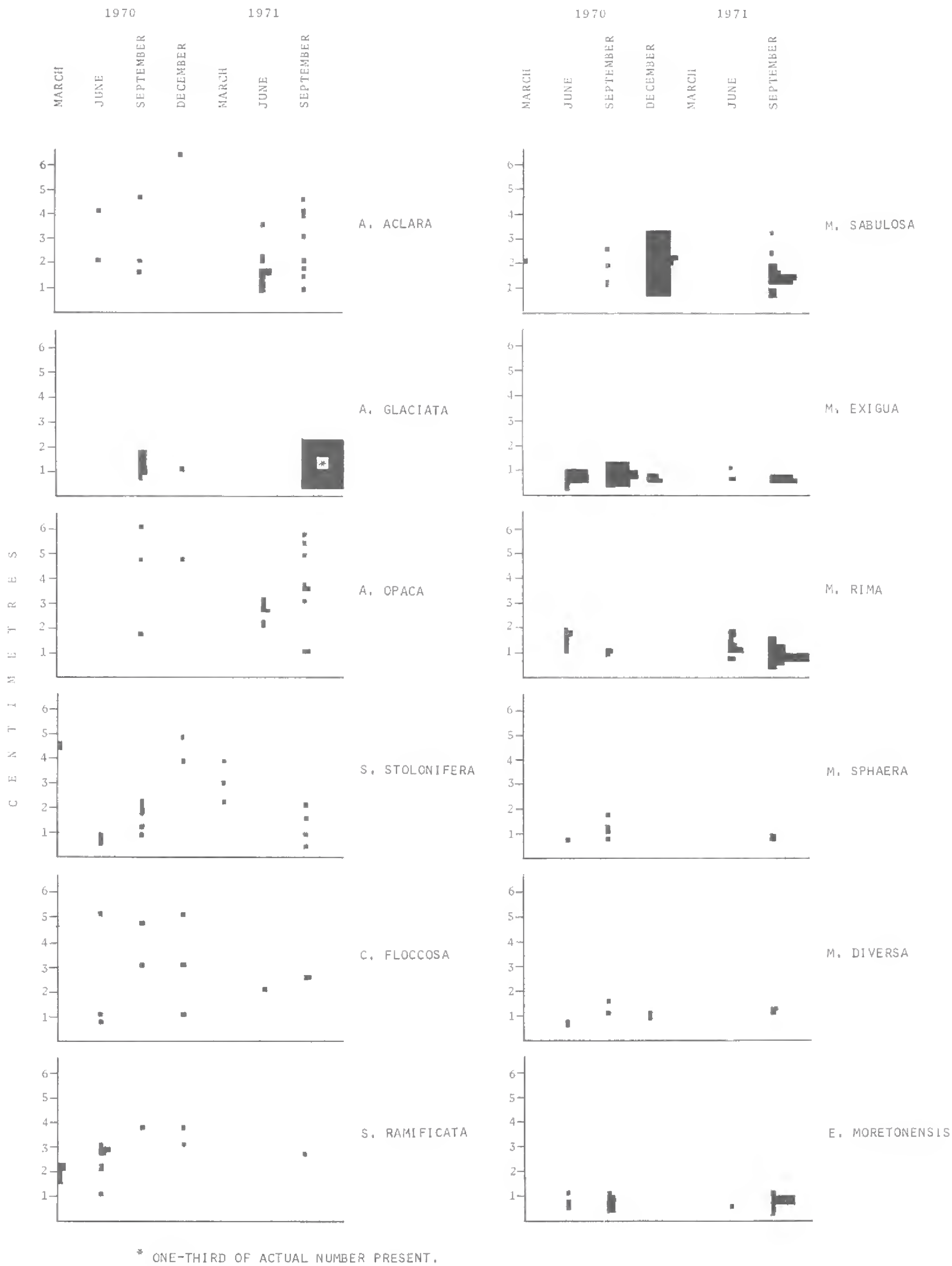


FIG. 26: Size and abundance of certain ascidian species in the survey area.

SEASONAL VARIATIONS

Species Periodicity (Figs. 25, 26): In 1970 there was a high rainfall in the Logan and Albert Rivers catchment area in the period Jan.–Feb. After that only low falls were recorded until December 1970 when a normal summer rainfall continuing until March 1971 occurred. There followed a dry winter with little or no rain up to October 1971. Surface temperatures for the Logan River are available for 1952 (Rochford and Spencer, 1953) and in that year they reached their minimum in June and their maximum during December.

The disappearance of most species from the area during December may be associated with either the reduction in salinity that occurs during the period of maximum rainfall or the increase in temperature at that time (Rochford and Spencer, 1953). Most species re-appear in the fauna in the period June–September coinciding with the dry winter and the lowest temperatures of the year. Populations build up to reach their maximum in September. The uniform behaviour of populations of the great majority of species tends to confirm the reliability of the sampling methods.

Unfortunately there is not a great variation in the rainfall registered during 1970 and 1971. It is possible that the higher rainfall in February 1971 inhibited settlement of *Styela ramificata*, *S. stolonifera*, *Molgula sabulosa*, *M. exigua*, *M. diversa* and *M. sphaera*. On the other hand, greater numbers of *Agnesia glaciata*, *Molgula exigua* and *M. rima* settled in September 1971 than in 1970 and this may reflect a population increase that was not inhibited by an earlier rainfall such as that registered in 1970. In this respect *Adagnesia opaca* was taken in June 1971 but not in June 1970. There may be, however, other unidentified factors affecting the settlement of each species.

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A NEW SPECIES OF *DIGASTER* (MEGASCOLECIDAE: OLIGOCHAETA) FROM QUEENSLAND

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ABSTRACT

The new species, *Digaster gwongorellae*, is the ninth described species of a *lumbricoides* species-group within this endemic eastern Australian genus.

The endemic eastern Australian genus *Digaster* was the subject of a recent paper (Jamieson, 1971c) in which it was shown that the seven described digastric Queensland species and the type-species, *D. lumbricoides* Perrier, from New South Wales, were assignable to a homogeneous *lumbricoides* species-group. An eighth, then undescribed, Queensland species from Springbrook was included in the *lumbricoides* group and is described in the present account.

Digaster gwongorellae sp. nov.

(Fig. 1A–C)

Holotype: Gwongorella National Park, southeast Queensland, 153° 14′ East 28° 06′ South; elevation c. 950 metres; in rainforest soil under leaf litter, collector E. Bradbury, 10.iv.1970, QM. G6360.

Paratypes: 2, same data as holotype but collected 5.vi.1970; paratype 1, QM. G6361; paratype 2 in author's collections.

External Anatomy

The holotype (H) and paratype 1 (P1) are complete; paratype 2 (P2) is a posterior amputee. Length 70–102 mm, width (midclitellar) 4 mm; number of segments 150–152 (P1 and H, respectively).

Segments in the forebody weakly biannulate; no appreciable annulation more posteriorly. Slender, circular in cross section throughout. Prostomium tanylobous (H; P1, 2). First dorsal pore 5/6 faint; pores conspicuous from 6/7 (H; P2). Clitellum annular, XIV-XVIII; dorsal pores and intersegments (except ventrally) obliterated. Setae commencing on II; in 8 regular longitudinal rows throughout. Setae *a* and *b* absent in XVIII (H; P1, 2).

Male pores minute, equatorial in XVIII, in *b* lines, on very small, inconspicuous papillae which indent the lateral borders of a midventral unpaired flat-topped, subcircular moderately protuberant genital marking. The marking extending from the posterior border

TABLE 1

INTERSETAL DISTANCE IN SEGMENT XII IN *Digaster gwongorellae*

	mm					st*					dd: u
	aa	ab	bc	cd	dd	aa	ab	bc	cd	dd	
Holotype	0·52	0·35	0·73	0·56	6·80	4·95	3·30	6·93	5·28	64·02	0·64
Paratype 1	0·42	0·21	0·51	0·42	5·85	4·97	2·48	6·01	4·97	68·04	0·68
Paratype 2	0·42	0·27	0·55	0·46	5·14	5·26	3·28	6·79	5·70	63·16	0·63
mean						5·06	3·02	6·58	5·32	65·07	0·65
mean/ab						1·68	1·00	2·18	1·76	21·55	

* Standardized to a periphery (*u*) of 100.

of XVIII into the postsetal portion of XVII and surrounded by a whitish, lower rim which almost reaches the setal arcs of XVII and XIX and expands lateral of the male porophores to *c* lines (H). Male genital field similar in the paratypes but less well developed in P1; indistinct in P2; the genital marking with a distinct median pore equatorially in XVIII in H and P2. Female pore very conspicuous, unpaired, midventral, midway between the setal arc and anterior border of XIV; the segment protuberant in its vicinity. Spermathecal pores visible as 2 pairs of indistinct points immediately behind intersegmental furrows 7/8 and 8/9 in *a* lines, very slightly bowing the intersegments anteriorly (H; P1, 2).

INTERNAL ANATOMY (Holotype and paratype 2; gross anatomy confirmed in P1)

Septa 5/6 thin; 6/7–9/10 increasing from slightly to moderately thick; 10/11–12/13 strongly thickened; 13/14 moderately thickened; the rest thin (H, P2). Dorsal blood vessel single; continuous to the brain over which it ramifies. Dorsoventral commissurals in V–XII; those in V–IX slender and (all?) with parietal branches; those in X–XII forming wide latero-oesophageal hearts, each with a connective from the dorsal and from the supra-oesophageal vessel but otherwised unbranched. Supra-oesophageal in IX–XII. Subneural vessel absent (H, P2). Each of a pair of vessels much ramified dorsally on the pharynx immediately behind the brain passes downwards around the gut, and runs posteriorly as far as XII as a thick paired suboesophageal vessel; a pair of posterior lateroparietal vessels to the prostates originates ventrally from vascularization of the oesophagus in XIII (H).

Oesophagus in V concealed by pharyngeal glands, not dilated and only moderately vascularized. Gizzards two, in VI and VII, fusiform and very strongly muscular, closely abutting and not separated by unmodified oesophagus but clearly demarcated one from the other. Oesophagus in VIII virtually supressed; in IX only slightly dilated and moderately vascularized, in X–XVI (H), XVII (P2) strongly vascularized, and dilated to XVI (H) or XIII (P2); calciferous glands absent. Intestine commencing in XVIII; typhlosole absent (H; P1, 2).

Nephridia: a pair of very small meronephric masses in II, apparently discharging exonephrically at 1/2; a pair of very large meronephric tufts composed of numerous spiral loops in III and IV discharging by several ducts at 2/3 and 3/4; thereafter, to XII, separate

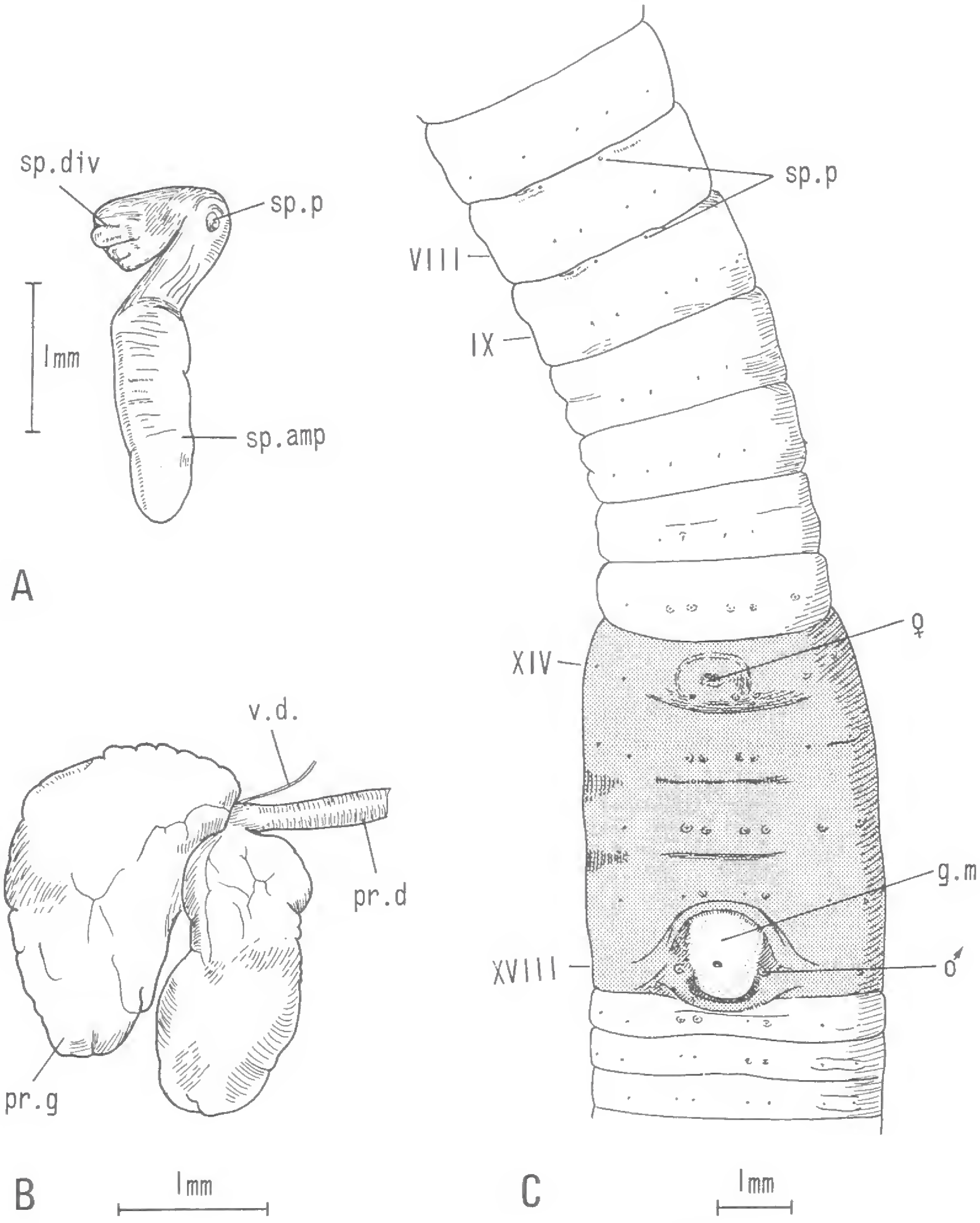

FIG. 1: *Digaster gwongorellae* sp. nov. (holotype) A, right spermatheca of IX; B, prostate gland; C, ventral view of genital segments.

All by camera lucida. ♀, female pore; g.m., genital marking; ♂, male pore; pr. d., prostate duct; pr. g., glandular portion of prostate; sp. amp., spermathecal ampulla; sp. d., spermathecal duct; sp. div., spermathecal diverticulum; sp. p., spermathecal pore; v. d., vas deferens.

exonephric micromeronephridia on posterior septa; these by XIII becoming parietal. Caudally the median nephridium is not appreciably enlarged but a preseptal funnel is present (H, P2).

Small testes and large, multipartite iridescent sperm funnels in X and XI; seminal vesicles in IX and XII; the posterior pair (H) or both pairs (P2) racemose. Prostates racemose, restricted to but expanding XVIII; each gland completely bipartite; the duct straight and muscular entering the body wall in *a* line; vasa deferentia joining the junction of gland and duct. Ovaries (flattened, composed of several egg strings) and thick-lipped funnels in XIII; oviducts almost contiguous on entering the body wall in XIV; ovisacs absent. Spermathecae 2 pairs, in VIII and IX, discharging anteriorly in their segments; each with a narrow elongate ovoid ampulla, a slightly shorter, narrower, clearly demarcated muscular duct and ectally a large diverticulum, wider than the duct and almost as long, with several externally protuberant sperm chambers (H, P2). Length of right posterior spermatheca of holotype = 2·3 mm; ratio of total length: length duct = 2·8; ratio of total length: length diverticulum = 2·5.

Discussion

Digaster gwongorellae is distinguished from all other members of the *lumbricoides* species-group, to which it closely conforms, in the single midventral female pore, in extension of the clitellum through five complete segments, in the form of the male genital field and in location of the first dorsal pore in intersegment 5/6. The bipartite condition of the prostate glands is seen also in *D. bradburyi* and *D. anomala* Jamieson, 1971a. The form of the spermathecae is not especially distinctive, their general form, and particularly the multiloculate diverticulum, being reminiscent of *Digaster minor* Spencer; *D. lamingtonensis* Michaelsen and (outside the *lumbricoides* group) *D. armifera* Fletcher; the diverticulum is, however, more elongate in *D. gwongorellae*.

Inclusion of *Digaster* in the Tribe Dichogastrini Jamieson (1971b) on the grounds of presence of a stomate nephridium median to astomate meronephridia in posterior segments is further validated by the new species.

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HYBRIDIZATION IN THE AVIAN GENUS *MYZANTHA*

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ABSTRACT

Three *Myzantha melanocephala* × *M. flavigula* hybrids are described. One was discovered in May and the others in December 1970 at the same place near Meandarra, Queensland. Those in December were young birds being fed by adults of both species. There is some habitat separation between these species in regions of sympatry, and sporadic hybridization could be widespread.

While studying aspects of ecology and behaviour of Noisy and Yellow-throated Miners, *Myzantha melanocephala* and *M. flavigula*, six kilometres west of Meandarra, Queensland, on 29 May 1970, my attention was drawn by the activities of a single bird foraging in a narrow strip of brigalow. This was unusual in itself, for miners in this region generally forage in small flocks. The bird's behaviour was more similar to that of *M. flavigula* than *M. melanocephala* in that much time was spent gliding and swooping between trees and about their outer foliage.

In flight, the white rump, a diagnostic character of *M. flavigula*, was quite obvious. When the bird landed, however, the black on the crown, cheeks, and throat, typical of *M. melanocephala*, was the most noticeable feature. A mist-net was set up and the bird quickly lured by tape-recordings of a communal display of *M. melanocephala*. The commotion attracted a few individuals of both species to the spot, but they did not remain long.

In the hand, the bird clearly possessed plumage characters of both species. The whitish-grey rump was similar to that found among specimens of *M. flavigula* occurring in the same region. The head pattern, however, although not as dark as that of adults of *M. melanocephala* was unmistakably of the pattern typical of that species. The throat possessed a trace of yellow as is found in *M. melanocephala*, not the high intensity characteristic of *M. flavigula*. There was absolutely no trace of yellow on the forehead. (I have never seen yellow on the foreheads of any of scores of Noisy Miners handled from the Meandarra or Brisbane areas. On the other hand, I have never handled a Yellow-throated Miner that lacked this feature.) The specimen was to be taken back to Brisbane for observation but was accidentally released a few days later from its temporary holding cage in Meandarra.

In captivity it was noted that certain of its vocalizations were lower than comparable ones of a Yellow-throated Miner being kept with it. However, there is considerable overlap in the range of vocalizations of the two species in this region, and they can hardly be con-

sidered as reliably diagnostic. The specimen was not measured, but considerable variation results from differences in age and sex, and weights and measurements can be considered as suggestive only. For example, means and standard errors of wing length for twenty-eight *M. melanocephala* and forty-seven *M. flavigula* from the Meandarra region were $130{\cdot}5 \pm 1{\cdot}07$ mm and $127{\cdot}9 \pm 0{\cdot}687$ mm. Weights are even more variable: $58{\cdot}9 \pm 0{\cdot}91$ g ($N = 28$) and $58{\cdot}5 \pm 1{\cdot}26$ g ($N = 39$) respectively. Although the mean wing measurements differ significantly ($P < 0{\cdot}05$; t-test), neither of these measurements can be used for specific identifications because of their overlapping ranges.

As the combination of features shown by this individual was unique and included highly diagnostic characters of two closely related species, it seemed reasonable to conclude that it was a hybrid.

On 15 December 1970 two more hybrids were discovered. They were fully grown, but not yet entirely independent. Several apparent adults were feeding them, as is typical for *M. melanocephala* (Dow, 1970) and *M. flavigula* (Dow, unpublished). They spent most of their time foraging at the edge of a small stand of brigalow and belah, 150 m south of the location at which the previously described hybrid had been found.

These birds were virtually identical, and presumably were siblings. Their overall coloration was more similar to that of *M. flavigula* than *M. melanocephala*. The white rump was conspicuous in flight, but the facial pattern, complete with the black lateral semicircle of *M. melanocephala*, was less dark than in the earlier hybrid. The forehead and the crown were more grey than in *M. melanocephala*. Despite the paleness, the pattern was distinctly that of *M. melanocephala*. Their flight was more similar to that of *M. flavigula*. I was unable to net these birds, but obtained some 35 and 16 mm coloured photographs of mediocre quality.

They uttered food-begging calls whenever approached by an adult, and tended to follow nearby adults. They were being fed by six Noisy Miners and one Yellow-throated Miner. Some of the Noisy Miners occasionally showed some aggression towards the Yellow-throated Miner, but no more than one would expect to a bird outside the resident group (see Dow, 1970). Three other Yellow-throated Miners were seen to move through the area in the next two days, but these never attempted to feed the juveniles. The Noisy Miners all belonged to a group residing in the area, and all had been colour-banded on 27 March 1970. The reproductive female of the group (WOO/060-05481) was observed incubating three eggs on 9 October 1970, 60 m from where the hybrids were now most often seen. The size and behaviour of the hybrids, and the absence of any other juveniles, suggested that they had indeed fledged from this nest, but my trips to this study-area have been too infrequent for continuous observations of nesting activity.

In the Meandarra region, 200 km west of the Great Dividing Range, the two species occupy slightly different habitats, *M. flavigula* being more often seen in open country with scattered trees and being very localized in distribution, *M. melanocephala* occupying more heavily wooded areas and riparian situations. The study-area from which these records were obtained was selected in 1969 because it represented a zone of overlap where the two species were fairly abundant and nested in small colonies, separated in places by less than one kilometre. Sometimes mixed flocks are seen there, usually when Noisy Miners move across open areas and are challenged by Yellow-throated Miners. Such encounters are usually

similar in nature to those of territorial groups of either species. I have never observed non-agonistic foraging flocks of mixed species, although both were at times attracted in large numbers to an artificial feeding station in nearby Meandarra.

Presumably there are many regions where the two species breed in such close proximity. Previous authors have remarked on habitat separations essentially similar to those I describe, and most report *M. melanocephala* as the species characteristic of timbered watercourses in regions of sympatry with *M. flavigula* (White, 1918; Lang, 1927; Sullivan, 1931; Chandler, 1937). Others, however, mention *M. flavigula* as favouring watercourses (Alexander, 1918; White, 1921). Some writers have implied that *M. melanocephala*, being a more robust species, actively usurps *M. flavigula* from more heavily wooded habitats (White, 1918; Sullivan, 1931). In the environs of Meandarra the patchy distribution of *M. flavigula* is noticeable, with small local populations being found in isolated pockets or colonies, often near populations of *M. melanocephala*. The town of Meandarra seems to be near the centre of a loose cluster of these isolated populations. I have found a few others but none farther than 38 km south of Meandarra at Westerling and Inglestone Stations, or farther than 50 km north at Condamine. I was unable to find local colonies of *M. flavigula* more than 4 km west of Meandarra, and, in fact, a transect of $\frac{1}{2}$-mile observation points along the Moonie Highway revealed none until west of St George, about 175 km west of the Meandarra population. To the east I have found local populations as far as South Glen (just west of Tara), i.e. 44 km from Meandarra. I have observed very small and isolated groups much farther east, between Jondaryan and Oakey, about 35 km west of the crest of the Great Dividing Range.

In all these places *M. flavigula* occupied much more open country than did *M. melanocephala*, except just west of St George, where it occupied more heavily wooded places. This patchy distribution is apparently typical, even in some regions where the species occurs alone (Sedgwick, 1947). A similar distribution of *M. melanocephala* apparently occurs in populations well inside the range of *M. flavigula* (McGill, 1944). So although interactions between the two species have not been described—some authors in regions of sympatry have noted that the species keep quite apart (Chisholm, 1940)—the opportunity for hybridization must exist in many localities.

Examination of 46 specimens of *M. melanocephala* and 26 of *M. flavigula* in the Queensland Museum revealed no hybrids and none with plumage variations sufficient to account for the three individuals described from the field. All specimens of *M. flavigula* and none of *M. melanocephala* had distinct yellow foreheads. As found in field observations, some yellow occurred on the throats of all specimens of *M. melanocephala*, although in two it was virtually absent. Only *M. flavigula* showed the whitish rump. Older specimens, particularly those of *M. flavigula* were badly 'foxed', but regional variation in coloration was nonetheless apparent. One specimen (Registration No. QM O6612) of *M. flavigula* appeared darker on the cheeks, back, rump, and breast than conspecific specimens, but not as dark as *M. melanocephala*. It had been collected near St George, Queensland, in the western half of the zone of sympatry.

Hybridization in the Meliphagidae is apparently uncommon. Gray (1958) lists only one known instance: interbreeding 'apparently' occurs between *Melidectes belfordi* and *M. leucostephes*.

Keast (1961, p. 387) states that hybrid zones do not occur in the Meliphagidae. And in his discussion of the *M. flavigula-obscura-melanotis* complex, Serventy (1953) did not mention any instances of hybridization among members of the genus, *flavigula* and *melanotis* behaving as good species where their ranges overlap, as do *flavigula* and *melanocephala*. I have been unable to find any published records of hybridization between these species. Meandarra populations do not show a wide range of intermediately plumaged individuals—but differences are subtle and extensive collections have not been made—so that hybridization may not be common. On the other hand, perhaps hybridization on wide fronts is not as uncommon as generally believed. The subtlety of specific plumage differences could mean that hybrid individuals would be easily overlooked. The white rump of *M. flavigula* is probably considered by field ornithologists to be the best diagnostic character of the species (Sullivan, 1931; Bryant, 1937; Chisholm, 1938; Jarman, 1945; Francis, 1949), hence the preference of some for the name White-rumped Miner (Officer, 1964, p. 72). In fact, one editor (in Elliot, 1938), stated in an emphatic footnote that no problem in field identification could arise between the species because 'the white rump of *M. flavigula* is an infallible guide.' If hybrid individuals follow the pattern of those I have described they undoubtedly would be identified as *M. flavigula* in flight and *M. melanocephala* when resting or foraging. Certainly, ornithologists should be aware of the possibility of hybridization between these species and should be on the look-out for intermediate individuals. Serventy (1953) stressed the need for study of *M. melanocephala*, *M. melanotis*, and *M. flavigula* in western Victoria and South Australia. Clearly, a wider study of the relationships of populations within the genus could profitably be made.

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NEW RECORDS OF FISHES OF THE GENUS *CALLIONYMUS* (PISCES: CALLIONYMIDAE) FROM THE NEW GUINEA REGION

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ABSTRACT

Based upon a small collection of dragonets, *Callionymus belcheri*, *C. schaapii*, *C. keeleyi* and *C. marleyi* are reported for the first time from the New Guinea Region. New locality records are given for other species.

Within the genus *Callionymus*, five species have been previously reported from the New Guinea Region (Munro, 1958, 1967). Those reported were *Callionymus calauropomus* Richardson (New Ireland) (for systematic changes see Johnson, 1971), *C. japonicus japonicus* Houttuyn (off Waigeu, Western New Guinea), *C. wilburni* Herre (Majalibit Inlet, Waigeu), *C. sagitta* Pallas (Bostrem Bay, Sek Harbour, Northern New Guinea) and *C. filamentosus* Cuvier (reported only from coastal waters with no specific localities given).

From a small collection of *Callionymus* spp. collected by the Department of Agriculture, Stock and Fisheries Research and Survey Station, Kanudi, Papua, I found 7 species, of which 4 are new to the New Guinea Region. In this paper the New Guinea Region comprises New Guinea, Papua, West Irian, New Britain, New Ireland, Bougainville and D'Entre-Casteaux Islands. I wish to express here my gratitude to Alan G. Hinton, L. W. Filewood and P. Kailola, Research and Survey Station, Kanudi, for allowing me to examine their collections and publish my findings. Professor J. M. Thomson, University of Queensland, and Professor Harold Heatwole, University of New England, reviewed the manuscript. This research was supported by A.R.G.C. and U.R.G. research funds to the University of Queensland. All length measurements are standard length (SL).

Genus **Callionymus**

Callionymus belcheri Richardson: Three specimens, two being trawled from Kinikini Bay (64 mm female; 80 mm male) on 3 January 1960 and one (78 mm male) trawled from the Sepik area, Northern New Guinea, in November 1965. These records are the first for this species in the New Guinea Region. *C. belcheri* is known from the eastern Australian coast. For a complete description of this species, see Johnson (1971).

Callionymus schaapii Bleeker: One male (58 mm) was trawled in Hall Sound, off Yule Island, Gulf of Papua, during March 1963. This is the first report of this species in the New Guinea Region. It is known from the Philippine Islands.

Callionymus keeleyi Fowler: One male (37 mm) was beam trawled from Port Moresby

Harbour, Papua on 7 January 1966. This species is also known from the Philippine Islands and has not previously been reported from the New Guinea Region.

Callionymus marleyi Regan: One male (60 mm) was trawled from the Sepik area in November 1965. All measurements and counts fit the description as given in Smith, 1963. The origin of the first dorsal is approximately twice as far from the caudal base as the snout tip. The fourth most anterior hook on the preopercular spine was just forming in this specimen, a subadult. *C. marleyi* is widespread in the West Indian Ocean. Specimens of *C. marleyi* have been confused with *C. sagitta* and it is possible that *C. sagitta* as reported by Munro (1958) from New Guinea might have been *C. marleyi*. This record of *C. marleyi* is the first for the New Guinea Region.

Callionymus japonicus japonicus Houttuyn: Two specimens were collected; one male (106 mm) was trawled off Yule Island, Gulf of Papua on 10 November 1969 and one male (175 mm) was trawled off Bramble Cay, Gulf of Papua. *Callionymus j. japonicus* has been reported from south of New Guinea and off Waigeu, West New Guinea. These records are the first for Papuan waters. For a detailed description see Johnson, 1971.

Callionymus filamentosus Cuvier: One female (73 mm) was trawled off Yule Island, Gulf of Papua on 29 November 1969. No locality records in the New Guinea Region have been published for this species, but reference was made by Munro (1967) that it occurred in coastal waters.

Callionymus wilburni Herre: Four specimens were collected, two males (26 and 27 mm) and one female (24 mm) were trawled in Queen Capoca Bay, Buka Island (near Bougainville) on 28 July 1969 and one male (22 mm) was collected with rotenone in Fairfax Harbour, Port Moresby on 28 August 1969. Sexual dimorphic characteristics such as dorsal fin length and anal papilla length were evident. In males 26 and 27 mm in SL, the first dorsal spine was elongated to about mid second dorsal length, when depressed, while in the female the first dorsal spine reached only to the second dorsal origin. The background colouration in these specimens was cream to white; 6 to 7 cross bars composed of fine dots were on the back with 8 lighter bars along the sides; first dorsal black posteriorly, anterior spines clear to dusky; second dorsal clear in 22 and 24 mm specimens and with brown spots on rays in specimens 26 and 27 mm; 4 rows of black spots on rays of pelvic fin; pectorals distally clear, light brown spots on rays basally; caudal clear with a few brown to black spots on membranes between rays; anal clear in female and with a dusky margin in males.

C. wilburni has been recorded from Western New Guinea (Munro, 1967) and these records constitute a first report for Papuan waters.

In conclusion, the above data suggest a closer affinity between the callionymid fauna of the New Guinea Region and the Philippine Islands than between that of the former region and those found in Australian waters.

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TYPE-SPECIMENS OF COCKROACHES (BLATTODEA) IN THE QUEENSLAND MUSEUM

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ABSTRACT

Types and probable types of 109 nominal species in the Queensland Museum collections are listed. These represent taxa described by Hebard, Mackerras, Rehn, Shaw, Shelford and Tepper.

The bulk of the Museum's cockroach material consists of a collection purchased from Dr Eland Shaw, a medical practitioner of Goodna near Brisbane. Dr Shaw described several new species in papers published during 1914–1925. Most of his type material is contained in the collection, that is, all types stated in his papers as 'Coll. Auct.' and 'Coll. Q. Mus.' (Shaw, 1925). In four cases Dr Shaw has described the unknown sex of another author's species. In such cases he has, in the literature and by label, designated his specimen as the Allotype. These have no type status, but have been included for the sake of completeness. They are indicated as 'Allotype: (Shaw)'. Dr Shaw kept a register of his material; his register numbers are included in this list and are prefixed by the letter S.

The collection has a number of specimens labelled as 'Cotype Tepper'. Some have type status, but others are obviously not from Tepper's original series. Confusion has arisen because Tepper did not label his type material until requested to do so some twenty years after his papers were published. In some cases he has labelled specimens which differ from the types in such details as sex and locality data. When labelling many of his specimens he used the words 'types' and 'cotypes' in the one series (Shaw, 1916). It would appear that Tepper used types to mean type of male and type of female without any indication as to which was the primary type. Cotype has been used in many ways by different authors and Tepper has used it to mean paratype. However, in the above situation types and cotypes would best be regarded as syntypes. In those cases where he has designated only one type and a cotype in the one series, the cotype becomes a paratype, for example, *Anamesia lambii* Tepper, 1893. Mackerras (1965a–c, 1966a–b, 1967a–b, 1968a–d) has clarified the position with respect to most of Tepper's types in the family Blattidae by selecting lectotypes. In the species concerned, Tepper's cotypes would become paralectotypes and are listed as such in this paper. Where lectotypes have not been selected, in other families, Tepper's types are listed as 'Syntypes(?)'. Clarification in these circumstances requires consideration of all of his type series. This is best left to a worker revising the other families.

The collection contains some Hebard types of Australian species. His type labels for *Balta* spp. bear the name *Mareta*, a name which he synonymised with *Balta* in the paper in which he describes these species (Hebard, 1943, p. 38).

There are thirteen species, represented by paratypes and one specimen labelled as a cotype, listed at the end of this paper. They are foreign species, thirteen of which were obtained in exchange from the Hebard collection in or about 1928. The remaining species was described by Shelford (1906, p. 234). It was labelled as a 'cotype' but no primary type was designated in Shelford's paper. It is included in this list as a syntype. This specimen was purchased as part of the Shaw collection.

When the Queensland Museum insect register was begun in 1911 it contained type and non-type material. The prefix letters varied with the order of the specimen being registered, for example, Hy = Hymenoptera, C = Coleoptera, O = Orthoptera (including cockroaches). A separate type register was begun in 1916 starting at 2001, the numbers 1–2000 being reserved, but never used, for Girault types. The non-type register was continued until 1945 (P5562). Different prefix letters were used for different orders in both registers. In 1950 (C5244) the prefix T was introduced for all orders in the type register. There is, therefore, an overlap of numbers with the possibility of having similar prefixes. This has happened several times and two type specimens may have identical members. In order to remove this overlap the prefix letter of all numbers in the type-only register has now been changed to T.

The type list has been organised alphabetically without regard to families. The names used are those under which they were originally described and, as such, some have conflicting meanings if grouped under the modern arrangement of families and sub-families. No attempt has been made to give full synonymies, but current accepted names are given. Locality data has been stated as it occurs on the labels, but where more information is available this is given in square brackets.

TYPE SPECIMENS OF AUSTRALIAN SPECIES

Anamesia lambii Tepper, 1893
Trans. R. Soc. S. Aust. **17**: 70

PARATYPE: T2895, ♀; Innamincka, [S. Aust.], W. Lamb, 27.5.[18]89. (Labelled as a 'Cotype' in Tepper's hand. Left middle tarsus missing.)

Austropolyphaga perkinsi Mackerras, 1968
J. Aust. ent. Soc. **7**: 149, figs. 1–3, pl. 1, fig. 1

HOLOTYPE: T6623, ♂; Carnarvon, [SE. Q.], 29.5.[19]54, F. A. Perkins. (This specimen was received minus the abdomen.)

Austropolyphaga queenslandensis Mackerras, 1968
J. Aust. ent. Soc. **7**: 151, figs. 4–5, pl. 1, fig. 5

HOLOTYPE: T6626, ♂; 6 m[iles] N. of Babinda, N[E]. Qld., 7.viii.1966, G. Monteith. (Specimen in spirit.)

Austrostylopyga quadrilobata Mackerras, 1968
Aust. J. Zool. **16**: 573, figs. 62, 66, 95, 107

HOLOTYPE: T6602, ♂; Binna Burra, S[E]. Q., 12.2.[19]64, G. B. Monteith.

PARATYPE: T6603, ♀; Tamborine Mt., S[E]. Q., 2,000 ft, Eland Shaw, –.iv.[19]19. (Posterior half of abdomen separated and carded on pin with specimen. Some tarsal segments missing.)

Balta bicolor Hebard, 1943
Monogr. Acad. nat. Sci. Philad. **4**: 87, pl. 9, fig. 8, pl. 11, figs. 7–8, pl. 13, fig. 1

HOLOTYPE: T5439, ♂; Brisbane, [SE. Q.], H. Hacker, 9.11.[19]25.

ALLOTYPE: T5440, ♀; data as above.

According to Hebard, the Q.M. should have at least three paratypes. There are none labelled as such in the collection.

Balta cinctella Hebard, 1943
Monogr. Acad. nat. Sci. Philad. **4**: 58, pl. 8, fig. 2, pl. 10, fig. 8, pl. 12, fig. 3

HOLOTYPE: T5413, ♂; Glenormiston, W. Qld, –.v.[19]16, Graham Mylne. (Pin corrosion damage, enlarged pin hole; specimen has been carded.)

ALLOTYPE: T5414, ♀; data as above.

Balta denticauda Hebard, 1943
Monogr. Acad. nat. Sci. Philad. **4**: 79, pl. 11, fig. 3

PARATYPE: T5433, ♀; Kuranda, [NE.] Queensland, II.4.1925, F. P. Dodd. (A ♂ from Cairns, NE. Q., labelled as *B. denticauda* by *Hebard* may be the ♂ paratype mentioned in Hebard's monograph, but it is not labelled as such.)

Balta fragilis Hebard, 1943
Monogr. Acad. nat. Sci. Philad. **4**: 48, pl. 10, fig. 3

HOLOTYPE: T5409, ♂; National Park [= Lamington Nat. Park], [SE.] Q., at low elevation, 23.12.[19]22

ALLOTYPE: T5410, ♀; National Park, [SE. Q.], H. Hacker, –.Dec. 1923. (Minus abdomen.)

PARATYPES: T5411–12, T5434, T5442; 4 specimens from Tamborine Mt and Lamington Nat. Pk, SE. Q. (T5442 minus abdomen, wings and legs; T5412 left fore-wing spread and left hind-wing separated, spread and carded on the pin with the specimen; T5411 both pairs of wings spread.)

Balta fratercula Hebard, 1943
Monogr. Acad. nat. Sci. Philad. **4**: 69, pl. 9, fig. 4, pl. 10, fig. 12

According to Hebard the Q.M. should have a paratype of ths species. There are no specimens labelled as such in the collection. Records show that no paratype was received.

Balta luteicosta Hebard, 1943
Monogr. Acad. nat. Sci. Philad. **4**: 72, pl. 8, fig. 9, pl. 10, fig. 13

HOLOTYPE: T5404, ♂; Cairns, N[E]. Q., [19]20, J. F. Illingworth, coll. ex light.

PARATYPE: T5405, ♂; data as above.

Balta nebulosa Hebard, 1943
Monogr. Acad. nat. Sci. Philad. **4**: 82, pl. 10, fig. 17

HOLOTYPE: T5416, ♂; National Park [= Lamington Nat. Park], [SE.] Q., H. Hacker, –.Dec. 1921.

ALLOTYPE: T5417, ♀; National Park, [SE.] Q., H. Hacker, –.Nov. 1920.

PARATYPES: T5418–19; 2 specimens from National Park SE. Q. (T5418 minus abdomen.)

Balta praestans Hebard, 1943
Monogr. Acad. nat. Sci. Philad. **4**: 84, pl. 9, fig. 6

HOLOTYPE: T5435, ♂; Brisbane Dist. [SE.] Q., Eland Shaw, (Goodna, –.vi.[19]23 on reverse of label. All wings spread.)

ALLOTYPE: T5436, ♀; Brisbane Dist., [SE.] Q., Eland Shaw, (Goodna, –.ii.[19]24 on reverse of label.)

PARATYPE: T5437, ♂; Brisbane, [SE. Q.], H Hacker, 1911.[19]13.

Balta pusilla Hebard, 1943

Monogr. Acad. nat. Sci. Philad. **4**: 60, pl. 9, fig. 1, pl. 10, fig. 9, pl. 12, fig. 4

HOLOTYPE: T5406 ♂; Cairns, N[E.] Q., 1910, J. F. Illingworth, coll. ex scrub. (Published date 1923.)

PARATYPES: T5407–8, T5415; 3 specimens from Cairns and Gordonvale, NE. Q.

No allotype is present as stated by Hebard. One of the ♀ paratypes, T5415, has data matching that published for the allotype.

Balta serraticauda Hebard, 1943

Monogr. Acad. nat. Sci. Philad. **4**: 81, pl. 9, fig. 12, pl. 11, fig. 4

HOLOTYPE: T5420, ♂; Dunk Island, [NE. Q.], H. Hacker, –. Aug. 1927.

ALLOTYPE: T5421, ♀; data as above.

PARATYPE: T5422, ♂; data as above.

Balta toowoomba Hebard, 1943

Monogr. Acad. nat. Sci. Philad. **4**: 90, pl. 9, fig. 13, pl. 11, fig. 9

HOLOTYPE: T5441, ♂; Toowoomba, [SE.] Queensland, R. Illidge. (These data vary from those published in the absence of 'Aubigny' and the presence of 'R. Illidge'. Minus abdomen and metathorax; both fore-wings present, one separated and carded with specimen; only one hind-wing present, carded on pin with specimen.)

Balta transversa Hebard, 1943

Monogr. Acad. nat. Sci. Philad. **4**: 85, pl. 9, fig. 7, pl. 11, fig. 6

HOLOTYPE: T5438, ♂; National Park, [= Lamington Nat. Park], [SE.] Q., H. Hacker, –. Nov. 1920. (Minus all right legs.)

Balta verticalis Hebard, 1943

Monogr. Acad. nat. Sci. Philad. **4**: 67, pl. 8, fig. 7, pl. 11, fig. 10

HOLOTYPE: T5390, ♂; Gordonvale, N[E]. Q., [19]17, J. F. Illingworth, coll. ex light. (Ventral thorax damaged, most of the legs are absent.)

ALLOTYPE: T5391, ♀; Gordonvale, N[E]. Q., –.7.1917, J. F. Illingworth, collector.

PARATYPES: T5392–403; 12 specimens from Cairns and Gordonvale, NE. Q. (T5402 left hind-wing separated, spread and carded on pin with specimen; T5400 minus abdomen.)

Calolampra candidula Shaw, 1925

Proc. Linn. Soc. N.S.W. **50**: 175

HOLOTYPE: T2880, ♂; Bellvue, C.Q., Gt. 11 Railway, E. C. Sturtridge, 1917, S271. (Genitalia now mounted on a slide T2880a.)

PARATYPE: T2880, ♂; Powella, Aramac, C.Q., –.8.1920, F. Bradshaw, S423.

Choristimoides annectens Hebard. 1943

Monogr. Acad. nat. Sci. Philad. **4**: 31, pl. 5, fig. 8, pl. 6, figs. 1–7

ALLOTYPE: T5389, ♀; Tamborine Mountain, [SE. Q.], H. Hacker. (Carded; left fore-wing has two tears at right angles to the posterior margin.)

Hebard's paper states that one ♀ paratype is in the Q.M. There is no specimen labelled as such. Records show that no paratype was received.

Cosmozosteria brisbanensis Shaw, 1925

Proc. Linn. Soc. N.S.W. **50**: 194

(= *Cosmozosteria subzonata* (Tepper, 1894) after Mackerras, 1967a, p. 601)

HOLOTYPE: T2893 ♂; Brisbane Dist., [SE.] Q., Eland Shaw, S427. (Birkdale, 21.vi.[19]16, on reverse of label. Minus left middle leg.)

ALLOTYPE: T2893a, ♀; Brisbane Dist. [SE.] Q. Eland Shaw, (Wynnum, 6.xi.[19]16), S428.

PARATYPES: T2893; 27 specimens from various localities in SE. Queensland. (Shaw mentions 32 specimens.)

Cosmozosteria sloanei Shaw, 1925
Proc. Linn. Soc. N.S.W. **50**: 194

HOLOTYPE: T2894, ♂; Laura, [NE.] Q., Cooktown, –.vii.[19]16, T. S. Sloane, S425. (Right hind tibia and tarsus separated and carded on pin with specimen.)

ALLOTYPE: T2894a, ♀; Kuranda, [NE.] Queensland, S426. (Minus left fore-leg.)

Cutilia brevitarsis Shaw, 1922
Proc. Linn. Soc. N.S.W. **47**: 228
(= *Platyzosteria* (*Melanozosteria*) *kellyi* (Shaw, 1918) after Mackerras, 1968a, p. 262)

HOLOTYPE: T6476, ♂; Cairns, N[E]. Q., –.[19]17, J. F. Illingworth collector, S233. (Minus left hind tarsus.)

ALLOTYPE: T6477, ♀; data as above, S234. (Minus left fore tarsus.)

PARATYPES: T6478–85, T6498; 9 specimens from Cairns, Gordonvale and Babinda, NE. Q. (Original block register number for all above types, O/2853, cancelled.)

Cutilia feriarum Shaw, 1922
Proc. Linn. Soc. N.S.W. **47**: 230, fig. 6
(= *Platyzosteria* (*Melanozosteria*) *feriarum* (Shaw) after Mackerras, 1968a, p. 298)

HOLOTYPE: T6486, ♂; Stanthorpe [SE.] Q., –.1.[19]21, Biddy Shaw, S252. (Both hind legs separated and carded with specimen, one minus its tarsus; minus left middle leg and left fore tarsus.)

ALLOTYPE: T6487, ♀; Wilson's Downfall, [NE.] N.S.W., –.[19]21, Biddy Shaw, S254. (Mounted upside down; minus right fore-leg and all tarsi except left fore tarsus.)

PARATYPE: T6488, ♀; data as for allotype. (Bears a label 'belongs to *Platyzosteria* H.M.C.' Original block register number for all above types O/2854 cancelled.)

Cutilia illingworthi Shaw, 1922
Proc. Linn. Soc. N.S.W. **47**: 227, figs. 3–4
(= *Platyzosteria* (*Melanozosteria*) *illingworthi* (Shaw) after Mackerras, 1968a, p. 255)

HOLOTYPE: T6470, ♂; Cairns, N[E]. Q., –.[19]17, J. F. Illingworth, collector, S136. (Minus right hind tibia and tarsus.)

ALLOTYPE: T6471, ♀; data as above, S137.

PARATYPES: T6472–5; 4 specimens from Cairns, NE. Q. (Original block register number for all above types O/2851 cancelled.)

Cutilia insularis Shaw, 1925
Proc. Linn. Soc. N.S.W. **50**: 188
(= *Platyzosteria* (*Melanozosteria*) *insularis* (Shaw) after Mackerras, 1968a, p. 246)

PARATYPES: T6489–96; 8 specimens from Lord Howe Island, [SW. Pacific Ocean], A. M. Lea. (Shaw did not publish a full description of this species. It is mentioned as part of a key on p. 188.)

Cutilia kellyi Shaw, 1918
Mem. Qd Mus. **6**: 161, fig. 14
(= *Platyzosteria* (*Melanozosteria*) *kellyi* (Shaw) after Mackerras, 1968a, p. 262)

HOLOTYPE: T2882, ♂; Lr. Burdekin Dist., N[E]. Q., 1915, L. Kelly.

Cutilia melanesiae Shelford, 1909
Trans. R. ent. Soc. Lond. **1909**: 291
(= *Platyzosteria* (*Melanozosteria*) *melanesiae* (Shelford) after Mackerras, 1968a, p. 251)

'ALLOTYPE': T2881, ♀; Burdekin Dist. N[E]. Q., 1915, L. Kelly, S68. (Minus both hind tarsi. Shaw (1918, p. 160) invalidly selected this specimen as the allotype of Shelford's species.)

Cutilia nigrofasciata Shaw, 1918
Mem. Qd Mus. **6**: 160
(= *Platyzosteria* (*Melanozosteria*) *nigrofasciata* (Shaw) after Mackerras, 1968a, p. 285)

LECTOTYPE: T6446, ♂; Waddouring, [SW.] W.A., Oct. 1915–870, S93. (Selected by Mackerras, 1968a, p. 285.) (Minus all tarsi except those of right fore and hind legs.)

PARALECTOTYPE: T6447, ♀; data as above, S94, (Minus right hind tarsus. Original block register number for all above types, 0/2884, cancelled.)

Cutilia nitidella Shaw, 1918
Mem. Qd Mus. **6**: 155, figs. 6–8
(= *Platyzosteria* (*Melanozosteria*) *nitidella* (Shaw) after Mackerras, 1968a, p. 264)

LECTOTYPE: T6435, ♂; Wynnum, Brisbane Dist., [SE.] Q., Eland Shaw, 15.viii.[19]15, S11. (Selected by Mackerras, 1968a, p. 264.)

PARALECTOTYPES: T6436–45; 10 specimens (including the 3 remaining syntypes) from Brisbane district SE. Q. (T6438 and T6441 with oothecae.) (Original block register number for all above types, 0/2884, cancelled.)

Cutilia philpotti Shaw, 1922
Proc. Linn. Soc. N.S.W. **47**: 229
(= *Melanozosteria soror* Brunner, 1865 after Princis, 1957, p. 101)
(= *Platyzosteria* (*Melanozosteria*) *soror* Brunner, 1865 after Mackerras, 1968a, p. 256)

HOLOTYPE: T2852, ♂; Invercargill, N.Z. in fruit shop, A. Philpott, S110. (Minus right fore and hind tarsi, left fore tibia and tarsus.)

Cutilia spryi Shaw, 1922
Proc. Linn. Soc. N.S.W. **47**: 228, fig. 5
(= *Platyzosteria* (*Melanozosteria*) *spryi* (Shaw) after Mackerras, 1968a, p. 29)

HOLOTYPE: T6461, ♂; Spring Bluff, [SE.] Q., –.i.[19]19, B. Shaw, S237. (Minus left hind tarsus.)

ALLOTYPE: T6462, ♀; data as above, S238.

PARATYPES: T6463–9; 7 specimens from Spring Bluff, SE.Q. (T6467–9 mounted upside down, T6465–9 each with a fore-leg separated and carded with the specimen. Original block register number for all above types, O/2850, cancelled.)

Cutilia tepperi Shaw, 1918
Mem. Qd Mus. **6**: 157, figs. 9–10
(=*Platyzosteria* (*Melanozosteria*) *tepperi* (Shaw) after Mackerras, 1968a, p. 300)

LECTOTYPE: T6448, ♂; Dookie, Victoria, 1913, L. Kelly, S18. (Selected by Mackerras, 1968a, p. 300.)

PARALECTOTYPES: T6449–58; 10 specimens (including the 3 remaining syntypes) 9 Dookie, 1 Wimmera, Victoria. (All specimens have been repinned and are in good condition except one paratype where pin corrosion has forced the abdomen off. The abdomen is no longer present. Original block register number for all above types, O/2887, cancelled.)

Cutilia uncinata Shaw, 1918
Mem. Qd Mus. **6**: 158, figs 11–13
(= *Platyzosteria* (*Melanozosteria*) *uncinata* (Shaw) after Mackerras, 1968a, p. 253)

LECTOTYPE: T6459, ♂; Lizard Is., N[E]. Queensland, W. J. Young, 17.vii.[19]16, S78. (Selected by Mackerras, 1968a, p. 253.) (Minus hind and right fore tarsi.)

PARALECTOTYPE: T6460, ♀; locality as above, 23.vii.1916, S77. (Minus both hind and left middle tarsi; one fore tibia with tarsus separated and carded with the specimen. Original block register number for all above types, O/2885, cancelled.)

Desmozosteria cincta Shelford, 1909
Trans. R. ent. Soc. Lond. **1909**: 303

'ALLOTYPE': T2897, ♂; Charleville, [S.C.]Q., P. Franzen. (Shaw (1925, p. 195) invalidly selected this specimen as the allotype of Shelford's species.)

Drymaplaneta communis Tepper, 1893
Trans. R. Soc. S. Aust. **17**: 110

Two specimens, S351–2, not from Tepper's type localities. They are labelled Cotype in a hand dissimilar to that of Tepper's and the label bears 'Id. A. M. Lea'. These specimens are taken as not having type status. (Shaw's register says 'marked cotype S.A. Museum'.)

Drymaplaneta obscuripes Tepper, 1893
Trans. R. Soc. S. Aust. **17**: 112
(= *Platyzosteria* (*Platyzosteria*) *obscuripes* (Tepper) after Mackerras, 1967b, p. 1236)

Two specimens from Fowlers B., [S. Aust.] which is not one of Tepper's type localities. They are labelled cotype in a hand dissimilar to that of Tepper's and are taken as not having type status. (Both are damaged.)

Drymaplaneta subbifasciata Tepper, 1893
Trans. R. Soc. S. Aust. **17**: 112
(= *Platyzosteria* (*Melanozosteria*) *subbifasciata* (Tepper) after Mackerras, 1968a, p. 260)

'ALLOTYPE': T2883, ♀; Daly River, N.T., 1913, C. G. Chapman; Id. Hope Mus. 1914., S17. (Shaw (1914, p. 106) invalidly selected adult ♂ and ♀ types of Tepper's species.)

PARALECTOTYPE: T6497; N. Terr. (All tarsi except right middle damaged; minus fore-legs; one leg, presumably left middle, minus tarsus, separated and carded with specimen.) (According to Shaw, 1914, this is one of the original cotypes which was presented to him by the South Australian Museum.)

Drymaplaneta submarginata Tepper, 1893
Trans. R. Soc. S. Aust. **17**: 111
(= *Drymaplaneta communis* Tepper after Mackerras, 1968b, p. 544)

One specimen from Cygnet R. [W. Aust.] which is not one of Tepper's type localities. It is labelled as a cotype in a hand dissimilar to that of Tepper's and is taken as not having type status.

Ectoneura pallidula Hebard, 1943
Monogr. Acad. nat. Sci. Philad. **4**: 16, pl. 1, figs. 5–6, pl. 2, figs. 1–2, pl. 3, fig. 1, pl. 4, figs. 1–2

HOLOTYPE: T5376, ♂; Brisbane Dist., [SE.] Q., Eland Shaw (Cleveland, –.iv.[19]17, W. Chataway on reverse of label). (One hind wing separated and pinned with specimen.)

ALLOTYPE: T5377, ♀; data as above.

PARATYPES: T5378–87; 10 specimens from the Brisbane district, SE. Q. (T5386 and T5393 carded together; T5379 minus head, prothorax and legs; T5386–87 minus abdomens; T5381 abdomen separated and carded on pin with specimen.)

Ectoneura pictifrons Hebard, 1943
Monogr. Acad. nat. Sci. Philad. **4**: 21, pl. 2, fig. 6, pl. 3, fig. 4, pl. 4, fig. 6

HOLOTYPE: T5388, ♂; Bunya Mountains, S[E]. Q., –.x.[19]19, A. J. Turner. (Left wings spread.)

Elfridaia ebomae Shaw, 1925
Proc. Lin. Soc. N.S.W. **50**: 174, figs. 1–2

HOLOTYPE: T2878, ♂; S.E. Papua, Oct. 1914–Apr. 1915, Eland Shaw, S362, (Samarai, 10.xi.[19]14 on reverse of label). (Minus left fore tarsus.)

ALLOTYPE: T2878a, ♀; data as above, S370, (Eboma Is. on reverse of label.)

PARATYPES: T2878; 27 specimens from Eboma Island, SE. Papua. (S392, an ootheca, missing from card; S390 minus abdomen and all but one hind leg; S388 mounted upside down.)

Ellipsidion affine Hebard, 1943
Monogr. Acad. nat. Sci. Philad. **4**: 106

PARATYPE: T5443, ♀; Babinda, N[E]. Q., J. F. Illingworth, coll. ex [label unfinished].

Ellipsidion amplum Hebard, 1943
Monogr. Acad. nat. Sci. Philad. **4**: 118, pl. 14, figs. 3–4

Hebard states Q.M. as having a paratype of this species. Records show that none was received.

Ellipsidion notabile Hebard, 1943
Monogr. Acad. nat. Sci. Philad. **4**: 116, pl. 14, fig. 1

ALLOTYPE: T5447, ♀; Stradbroke Island, [SE.] Q., H. Hacker, 3.12.[19]12.

PARATYPES: T5448–9; 2 specimens from Stradbroke Island, SE.Q.

Ellipsidion simulans Hebard, 1943
Monogr. Acad. nat. Sci. Philad. **4**: 107, pl. 12, fig. 3

HOLOTYPE: T5444, ♂; Mossman, N[E]. Q., J. F. Illingworth, coll. ex cane.

ALLOTYPE: T5445, ♀; data as above.

PARATYPE: T5446, ♀; data as above.

Epilampra aspera Tepper, 1893
Trans. R. Soc. S. Aust. **17**: 62
(= *Calolampra aspera* (Tepper) presumably after Kirby, 1904, p. 118, see Princis, 1963, p. 151)

SYNTYPE(?): T7023, ♂; The Peake [S. Aust.], C. C. Driffield, 9.10.[18]87.

There is a juvenile specimen from Ardrossan, S.A., labelled as a Cotype by Shaw(?). It is not from Tepper's type localities and is taken as having no type status.

Epilampra atra Tepper, 1893
Trans. R. Soc. S. Aust. **17**: 65
(= *Calolampra atra* (Tepper) presumably after Kirby, 1904, p. 118, see Princis, 1963, p. 151)

SYNTYPE(?): T7024, ♀; Sedan, S. Aust., –. Dec. [18]85, [F.] Rothe, S394. (Labelled as 'Cotype' by Tepper. Specimen damaged through pin corrosion, enlarged pin hole in dorsal metathorax; minus left fore and hind tarsi.)

Epilampra fraserensis Tepper, 1893
Trans. R. Soc. S. Aust. **17**: 59
(= *Calolampra fraserensis* (Tepper) presumably after Kirby, 1904, p. 118, see Princis, 1963, p. 150)

SYNTYPE(?): T7025, ♂; Fraser Ra[nge]. [S.W. Australia], –. Oct. [18]91, [R.] Helms. (From type locality. Specimen with right wings spread, forewing torn from posterior edge to halfway along wing, both wings with a pin hole at anterior margin.)

Epilampra propria Tepper, 1893
Trans. R. Soc. S. Aust. **17**: 64
(= *Calolampra tepperi* Kirby, 1903, after Princis, 1963, p. 151)

SYNTYPE(?): T7026, ♀; Goolwa, [S. Aust.], –. March. [18]86, Zietz. (From type locality. Minus right foreleg.)

Euzosteria lata Mackerras, 1965
Aust. J. Zool. **13**: 894, figs. 3, 13, pl. 1, fig. 7

HOLOTYPE: T6434, ♂; Hamel, W.A., December, 1913, R. Illidge. (Genitalia mounted between coverslips on pin with specimen.)

Euzosteria sordida Shaw, 1925
Proc. Linn. Soc. N.S.W. **50**: 176

HOLOTYPE: T2876, ♀; Beverley, [SW.] W.A., F. H. du Boulay, S415.

Euzosteria tuberculata Shaw, 1925
Proc. Linn. Soc. N.S.W. **50**: 177, fig. 4

HOLOTYPE: T2877, ♀; Raak Plains, Malee District, Victoria, 1918, M. Wilson, S69. (Minus all tarsi.)

ALLOTYPE: T2877a, nymph; Lake Hattah, Vict., –.i.[19]18, Dixon, S417. (Minus right middle leg and all tarsi except those of fore legs.)

PARATYPES: T2877; 2 specimens from Ouldea and Murray River, Victoria. (Shaw's paper mentions 3 paratypes.)

Geoscapheus giganteus Tepper, 1894
Trans. R. Soc. S. Aust. **18**: 176
(=*Macropanesthia gigantea* (Tepper) after Shaw, 1925, p. 211)

'ALLOTYPE': T2862, ♀; Stanthorpe [SE.] Q., –.v.[19]18, T. Rice, S399. (Shaw (1925, p. 211) invalidly selected this specimen as the allotype of Tepper's species.)

Ischnoptera brunneonigra Tepper, 1895
Trans. R. Soc. S. Aust. **19**: 155

'SYNTYPES': T2888, 2♂; S1, Healsville Dist. Victoria (Healsville, 24.xi.[19]12 on reverse of label); S2, Healsville Dist. Victoria (Healsville, 4.xii.[19]12 on reverse of label). (Both have suffered through pin corrosion but all parts are present except for some legs. Shaw (1916, p. 87) invalidly selected these as cotypes of Tepper's species.)

Ischnoptera obscura Tepper, 1893
Trans. R. Soc. S. Aust. **17**: 54

One specimen labelled as a cotype from Burnside [S. Aust.]. This is not one of Tepper's type localities and this specimen is taken as not having type status.

Methana athertonensis Mackerras, 1968
Aust. J. Zool. **16**: 531, figs. 19–21, pl. 9, fig. 77

PARATYPE: T6909, ♀; Kuranda [NE.] Q., F. P. Dodd. (Genitalia mounted between coverslips and mounted on the pin with the specimen; minus left hind and right middle tarsi.)

Methana mjobergi Shaw, 1925
Proc. Linn. Soc. N.S.W. **50**: 201, figs. 22–23

PARATYPES: T2874, 2 specimens from Cedar Creek, [NE.] Queensl., Mjöberg, S409–10. (Both with left wings spread; S410 minus left middle leg.)

Methana parva Shaw, 1925
Proc. Linn. Soc. N.S.W. **50**: 200, fig. 21

HOLOTYPE: T2873, ♂; Green I., Brisbane Dist. [SE. Q.], Eland Shaw, S353. (All wings spread, right middle and left hind legs minus tarsi; right front, hind, and left middle legs separated; two legs complete pinned beneath specimen; left hind wing with large tears in costal margin and anal area.)

ALLOTYPE: T2873a, ♀; collection data as above, S354.

PARATYPES: T2873; 6 specimens from Green I., Tamborine, and Lamington National Park, SE. Q. (Shaw mentions 8 paratypes.)

Methana sjostedti Shaw, 1925
Proc. Linn. Soc. N.S.W. **50**: 201

PARATYPES: T2899; 2 specimens from Kuranda, NE. Q. (One damaged: right middle leg separated and carded on pin with specimen; pin corrosion damage, a hole in right fore-wing and thorax split on this side.)

Neolaxta monteithi Mackerras, 1968
J. Aust. ent. Soc. **7**: 143, figs. 1–4, pl. 1, figs. 1–6

HOLOTYPE: T6621, ♂; Tooloom, [NE.] N.S.W., 30.12.[19]66, G. B. Monteith. (All wings spread.)

PARATYPE: T6622, ♀; ex C.S.I.R.O. colony No. 244, Canberra, A.C.T., ex Tooloom, [NE.] N.S.W.

Oniscosma minima Shaw, 1925
Proc. Linn. Soc. N.S.W. **50**: 207
(= *Laxta minima* (Shaw) after Princis, 1963, p. 147)

HOLOTYPE: T2867, ♂; Bunya Mountain, [SE.] Q., H. Tryon, –.x.[19]19, S246. (Specimen originally pinned, now glued to a point.)

PARATYPES: T2867, 2 nymphs; data as above, S247–8. (Both originally pinned, now glued on points; S247 damaged, right meso and metathorax minus a triangular piece.)

Panesthia obtusa Shaw, 1918
Mem. Qd Mus. **6**: 165, fig. 15

SYNTYPES: T2859, 2 specimens; ♂, Manly, Brisbane District, [SE.] Q., Eland Shaw, 9.ix.[19]17, S.87; ♀, Spring Bluff, [SE.] Q., W. G. Jones, –.ii.[19]17, S88. (Fully winged, all wings spread.)

There are 3 additional specimens from Armidale, N.S.W. and Tamborine Mountain, SE. Q. labelled by Shaw as paratypes, S96, S157, S159. The latter is a nymph, originally pinned now glued to a card and has pin corrosion damage.

Panesthia parva Shaw, 1918
Mem. Qd Mus. **6**: 164

SYNTYPES: T2860, 4 specimens; ♂, Mt. Gravatt, Brisbane Dist., [SE.] Q., S64. (H. Tryon on reverse of label. Specimen fully winged, all wings spread.); 2 ♀, 1 ♂, Laidley, Brisbane Dist., [SE.] Q., Eland Shaw, 13.vii.[19]15, S82–4.

There are 32 specimens from Laidley, SE. Q. labelled by Shaw as paratypes. (S411 fully winged, wings not spread.)

Panesthia sloanei Shaw, 1918
Mem. Qd Mus. **6**: 166, fig. 16

HOLOTYPE: T2875, ♂; Cooktown, [NE.] Q., 'Tableland', 1600 ft, –.vii.[19]16, T. G. Sloane, S89.

PARATYPES: T2875, 4 specimens; locality as above. (Labelled by Shaw as paratypes.)

Panesthia tryoni Shaw, 1918
Mem. Qd Mus. **6**: 167, fig. 17

SYNTYPES: T2898, 2 specimens; ♂, National Park, Lamington, [SE.] Q., –.i.[19]17, 3000 ft, H. Tryon, S91; ♀, data as above, S92.

There are five specimens, data as above, labelled by Shaw as paratypes.

Pelmatosilpha(?) antipoda Kirby, 1903
Ann. Mag. nat. Hist. (7) **12**: 376
(= *Scabina antipoda* (Kirby) after Shelford, 1909, p. 306)

'ALLOTYPE': T7020, ♀; Tamborine Mt, S[E]. Q., 2000 ft, Eland Shaw, –.iii.[19]18, S95. (Shaw (1918, p. 163) invalidly selected this specimen as the allotype of Kirby's species.)

Periplaneta basedowi Tepper, 1904
Trans. R. Soc. S. Aust. **28**: 162, pl. 32

SYNTYPE?: T2879, ♀; NW. of S. Austr., H. Basedow, (July 1904 on pencil label attached). (Specimen labelled 'Cotype' in Tepper's hand. Both pairs of wings spread; minus right fore-leg and parts from all other legs.)

Periplaneta ignota Shaw, 1925
Proc. Linn. Soc. N.S.W. **50**: 205, figs. 27–8
(= *Periplaneta brunnea* Burmeister, 1838, after Swezey, 1936, p. 148 who gives M. Hebard as the authority.)

HOLOTYPE: T2868, ♂; Brisbane Dist., [SE.] Q., Eland Shaw, (Wynnum, J. Pannell, –.ii.[19]18 on reverse of label). (All wings spread.)

ALLOTYPE: T2868a, ♀; Brisbane Dist. [SE.] Q., Eland Shaw, (Wynnum, –.ii.[19]18 on reverse of label). (Wings not spread.)

Shaw's paper states that there are several paratypes in Q.M. collection and in his own. Specimens are present from his list of type localities, but he has apparently omitted to label them as paratypes.

Periplaneta jungii Tepper, 1895
Trans. R. Soc. S. Aust. **19**: 162
(= *Platyzosteria jungii* (Tepper) after Shelford, 1910, p. 7)
(= *Platyzosteria* (*Melanozosteria*) *jungii* (Tepper) after Mackerras, 1968a, p. 272)

T7021, ♀; S424. This specimen lacks any locality data. It was presented to Shaw by the South Australian Museum and bears a label 'Cotype *jungi* Tepper' in Shaw's (?) hand. Tepper's description is of the ♂ only and this specimen could not have been amongst Tepper's types. It is taken as not having type status.

Periplaneta scabriuscula Tepper, 1893
Trans. R. Soc. S. Aust. **17**: 108
(= *Platyzosteria* (*Melanozosteria*) *obscura* (Tepper) after Mackerras, 1968a, p. 278)

SYNTYPE(?): T7022, ♀; Pt Vincent, [S.A.], 1883, Haacke. (Minus left fore-leg and hind tarsus, right middle leg and hind tibia and tarsus.)

Plana crenulata Shaw, 1925
Proc. Linn. Soc. N.S.W. **50**: 209, fig. 32
(= *Geoscapeus crenulatus* (Shaw) after Princis, 1965, p. 327)

HOLOTYPE: T2861, ♂; Noosa Head [SE.] Q., H. A. Longman.

ALLOTYPE: T2861a, ♀; Noosa Head [SE. Q.], R. L. Higgins, 1919, S398. (Both are labelled as *Geoscapheus crenulatus* by Shaw and are minus all tarsi)

Platyzosteria anceps Shaw, 1925
Proc. Linn. Soc. N.S.W. **50**: 179, fig. 5
(= *Platyzosteria* (*Platyzosteria*) *anceps* Shaw, after Mackerras, 1967b, p. 1258)

HOLOTYPE: T2892, ♂; Uppr. Burnett Dist., [SE.] Q., –.ix.[19]20, C. Hogg. (Minus left hind leg.)

ALLOTYPE: T2892a, ♀; Mt Forbes, Rosewood, [SE.] Q., 1920, G. Dreveson. (Minus left hind tarsus.)

PARATYPES: T2892; 10 specimens from areas in SE. Q. (One paratype was labelled by Mackerras as '*Platyzosteria* sp. probably not *anceps*'. Shaw's paper mentions 13 specimens.)

Platyzosteria babindae Shaw, 1922
Proc. Linn. Soc. N.S.W. **47**: 224
(= ? *Platyzosteria* (*Platyzosteria*) *scabrella* Tepper, 1893 after Mackerras, 1967b, p. 1255)

HOLOTYPE: T2891, ♂; Babinda, [NE.] Q., –.xi.[19]19, J. F. Illingworth, S143. (Mackerras has attached a pink Holotype label, '*Platyzosteria babindae* Shaw, 1922, HOLOTYPE, stated in original description'. Shaw's label merely says 'Type of ♂'. Minus right mid and hind tarsi, left mid and hind tibia and tarsi.)

ALLOTYPE: T2891, ♀; data as above, S144. (Minus right hind tarsus.)

PARATYPE: T2891, 1 specimen labelled by Shaw from Babinda, S145. (None designated as such in Shaw's paper.)

Platyzosteria brigitae Shaw, 1914
Vict. Nat. **31**: 105
(= *Platyzosteria (Platyzosteria) biglumis* (Saussure, 1864) after Mackerras, 1967b, p. 1243)

LECTOTYPE: T2863, ♂; Healsville Dist., Vict., Eland Shaw, 29.ix.[19]12, S5. (Selected by Mackerras, 1967b, p. 1243.)

PARALECTOTYPE: T2863, ♀; same locality as above on 23.ii.[19]13, S6. (Pin corrosion damage to the metathorax, right fore and hind tarsi missing, one tarsus glued to locality label.)

Platyzosteria cingulata Shaw, 1922
Proc. Linn. Soc. N.S.W. **47**: 226
(= *Platyzosteria (Melanozosteria) cingulata* Shaw after Mackerras, 1968a, p. 292)

HOLOTYPE: T2866, ♂; Spring Bluff, [SE.] Q., –.i.[19]19, B. Shaw, S130. (Mackerras has attached a pink Holotype label, '*Platyzosteria cingulata* Shaw, 1922, HOLOTYPE, stated in original description.' Shaw's label merely says 'Type of ♂'. (Left rear leg separated and glued to Shaw's type label.)

ALLOTYPE: T2866, ♀; data as above, S131. (Minus all left tarsi.)

PARATYPES: T2866; 5 specimens from Spring Bluff, Stanthorpe, and Bunya Mts., SE. Q. (Shaw's paper mentions 7 paratypes.)

Platyzosteria exaspera Tepper, 1894
Trans. R. Soc. S. Aust. **18**: 182
(= *Platyzosteria castanea* (Brunner, 1865) after Shelford, 1909, p. 279)
(= *Platyzosteria (Melanozosteria) castanea* (Brunner) after Mackerras, 1968a, p. 267)

One specimen labelled 'Cotype' in a hand dissimilar to that of Tepper's. Its locality, Sydney, is not Tepper's type locality and the specimen is taken as not having type status.

Platyzosteria incurva Shaw, 1918
Mem. Qd Mus. **6**: 153, figs. 1–3
(= *Platyzosteria (Platyzosteria) incurva* Shaw after Mackerras, 1967b, p. 1250)

LECTOTYPE: T2865, ♂; Cleveland, Brisbane Dist., [SE.] Q., Eland Shaw, –.viii.1917, S7. (Chataway on reverse of label.) (Specimen mounted upside down on pin, minus both hind tarsi. Selected by Mackerras, 1967b, p. 1250.)

PARALECTOTYPES: T2865; 9 specimens, (including Shaw's 'Type of ♀') from Wynnum, Green I., and Brisbane District, SE. Q. (Shaw's paper does not designate paratypes.)

Platyzosteria latizona Tepper, 1893
Trans. R. Soc. S. Aust. **17**: 92
(= *Zonioploca latizona* (Tepper) after Shaw, 1925, p. 187)

PARALECTOTYPE: T2856, ♂; Mt Bryan E. [South Australia], 4.5.[18]89, Th. Best. (Labelled 'Cotype' in Tepper's hand. Lectotype selected by Mackerras, 1965, p. 917.)

Platyzosteria (Melanozosteria) perpolita Mackerras, 1968
Aust. J. Zool. **16**: 309, figs. 144, 162, pl. 3, G

HOLOTYPE: T7014, ♂; Bunya Mts., S[E]. Q., 3.5.[19]64, G. Monteith. (Minus right hind leg.)

PARATYPE: T7015, ♀; from Bunya Mts., SE. Q.

Platyzosteria pullata Shaw, 1914
Vict. Nat. **31**: 105
(= *Platyzosteria (Platyzosteria) melanaria* (Erichson, 1842) after Mackerras, 1967b, p. 1225)

HOLOTYPE: T2889, ♂; Baw Baw Plateau, [Victoria], 25–28.i.[19]14, J. Searle, S3. (Metathorax damaged slightly through pin corrosion, specimen now carded, minus right hind leg.)

Platyzosteria spatiosa Shaw, 1922
Proc. Linn. Soc. N.S.W. **47**: 226, fig. 2
(= *Platyzosteria* (*Platyzosteria*) *spatiosa* Shaw, after Mackerras, 1967b, p. 1241)

HOLOTYPE: T2864, ♀; Cunderdin, [S] W.A., October, 1913, R. Illidge, S123.

PARATYPE: T2864, ♀; data as above, S124.

Platyzosteria scabrella Tepper, 1893
Trans. R. Soc. S. Aust. **17**: 88
(= *Platyzosteria* (*Platyzosteria*) *scabrella* Tepper after Mackerras, 1967b, p. 1255)

PARALECTOTYPES: T7016–8; 3 specimens (2 on one pin) labelled as 'Cotypes' by Tepper from the type localities, Belair [S.A.], and Ravine des Casoars [Kangaroo I., S.A.]. (Lectotype selected Mackerras, 1967b, p. 1255.)

Platyzosteria (Platyzosteria) stradbrokensis Mackerras, 1967
Aust. J. Zool. **15**: 1273, figs. 86, 92, 98, pl. 3, fig. 1

HOLOTYPE: T6577, ♂; ex ♀ from Stradbroke I., [SE.] Q., –. May. 1965, G. Monteith. (*Platyzosteria* sp. ex jar No. 144, Canberra, A.C.T., 23.6.[19]65.)

PARATYPE: T6578, ♀; ex C.S.I.R.O. colony No. 144, Canberra, A.C.T., ex Stradbroke I. [SE. Q.].

Platyzosteria subarmata Shaw, 1918
Mem. Qd Mus. **6**: 154, figs. 4–5
(= *Platyzosteria* (*Platyzosteria*) *bifida* Saussure, 1873 after Mackerras, 1967b, p. 1240)

HOLOTYPE: T2890, ♂; Brisbane Dist., [SE.] Q., Eland Shaw, S4. (Laidley, 30.vi.[19]15 on reverse of label). (Minus left hind tarsus.)

PARATYPES: T2890; 2 specimens from Brewarrina, [Central N.] N.S.W. labelled as paratypes by Shaw.

Polyphagoides cantrelli Mackerras, 1968
J. Aust. ent. Soc. **7**: 152, figs. 6–9, pl. 1, figs. 2–4, 6–7

HOLOTYPE: T6624, ♂; Millaa Millaa Falls via Millaa Millaa, N[E]. Q., 10–11.xii.1966, B. Cantrell. (Genitalia mounted between coverslips and on pin with specimen; all wings spread.)

PARATYPE: T6625, ♀; Mt Lewis, via Jullaten, N[E]. Qld, 8.xii.1966, 3,500′, B. Cantrell. (Wings not spread.)

Polyzosteria fulgens Mackerras, 1965
Aust. J. Zool. **13**: 874, figs. 23, 35, pl. 1, fig. 8, pl. 2, figs. 6, 10

PARATYPES: T6432–33, ♂; W. Australia. (Both specimens are minus legs. They were selected as paratypes in this condition.)

Polyzosteria iridicolor Tepper, 1893
Trans. R. Soc. S. Aust. **17**: 73
(= *Polyzosteria obscuroviridis* Tepper, 1893 after Mackerras, 1965a, p. 864)

SYNTYPE(?): T7019, ♀; Gawler Ra. [S. Aust.], Jan. 1884, Andrews. (Labelled 'Cotype' in Tepper's hand. Mackerras has placed a label with this specimen, 'This specimen should have been chosen as the type of *P. iridicolor*.'.)

Polyzosteria pulchra Mackerras, 1965
Aust. J. Zool. **13**: 878, fig. 39, pl. 2, figs. 1–3, 9

PARATYPE: T6431, ♀; 20 m[iles] W. NW. of Mogumber [SW.] W.A., Jan. 1965, J. A. Mahon.

Stylopyga papuae Shaw, 1925
Proc. Linn. Soc. N.S.W. **50**: 204

HOLOTYPE: T2871, ♂; Kui-ara, SE. Papua, Oct. 1914–Apr. 1915, Eland Shaw, S420.

ALLOTYPE: T2871a, ♀; data as above, S421.

PARATYPE: T2871b, ♂; data as above, S422.

Stylopyga shelfordi Shaw, 1925
Proc. Linn. Soc. N.S.W. **50**: 203
(= *Austrostylopyga shelfordi* (Shaw) after Mackerras, 1968b, p. 564)

HOLOTYPE: T2870, ♂; Samford, Brisbane Dist., [SE.] Q., Eland Shaw, 1.v.[19]16, S418. (Cerci and left hind tarsus separated; one cercus glued to Shaw's type label, the other carded on a separate pin and numbered S418.)

ALLOTYPE: T2870a, ♀ data as above, S419. (Minus left fore-leg and left hind tarsus.

PARATYPES: T6251–85, T7026; 36 specimens Brisbane District, SE. Q. (All originally registered under the same number as the holotype.)

Temnelytra marksae Mackerras, 1968
Aust. J. Zool. **16**: 539, figs. 25, 29, 83

HOLOTYPE: T6601, ♂; Binna Burra [Macpherson Range] S[E]. Q., 12.2.[19]64, E. N. Marks.

Temnelytra tryoni Shaw, 1925
Proc. Linn. Soc. N.S.W. **50**: 197, figs. 18–19

HOLOTYPE: T2896, ♂; Nat. Park., Lamington, [SE.] Q., –.i.[19]17, 3000 ft, H. Tryon, S63. (In two parts when described by Shaw; the terminal abdominal segments are carded on a separate pin, S63a)

PARATYPE: T2896a, nymph; data as above, S397. (Damage to metathorax through pin corrosion, specimen carded.)

Tryonicus montanus Shaw, 1925
Proc. Linn. Soc. N.S.W. **50**: 202, figs. 24–26
(= *Tryonicus parvus* (Tepper, 1895) after Mackerras, 1968b, p. 557)

HOLOTYPE: T2872, ♂; Nat. Park, [SE.] Q., Macpherson Ra., –.xii.[19]18, H. Tryon, S334. (Minus rear tarsi; remounted on a micropin; labelled *Tryonia montana* by Shaw.)

ALLOTYPE: T2872a, ♀; Nat. Park, Lamington [SE.] Q., –.i.[19]17, 3000 ft, H. Tryon, S332. (Labelled *Tryonia montana* by Shaw.)

PARATYPES: T2872; 8 specimens from Lamington National Park. (All have corroded pins; 4 specimens broken in two; S330 abdomen carded on the pin with specimen; S325 genitalia mounted between coverslips on pin with specimen which is carded upside down.)

Zonioploca dixoni Shaw, 1922
Proc. Linn. Soc. N.S.W. **47**: 231, fig. 7
(= *Eppertia furcata* (Tepper, 1895) after Shaw, 1925, p. 187)

HOLOTYPE: T2858, ♂; C. Aust., C. French, S232. (Minus hind legs, left fore-leg and left middle tarsus.)

ALLOTYPE: T2858, ♀; S. Aust., C. F[rench], S251. (This specimen also bears a label by Shaw, '♀ Allotype (= *Teppertia furcata* Tepp.)'. (Minus left middle tarsus, right hind tarsus and left hind tibia and tarsus.)

Zonioploca occidentalia Mackerras, 1965
Aust. J. Zool. **13**: 908, figs. 3, 12, 21, pl. 1, fig. 3

PARATYPES: T6358, 60–62; 4 specimens from Cunderin, [SW. W.A.] and Mullewa [SW. W.A.].

TYPE-SPECIMENS OF FOREIGN MATERIAL

Anaplecta falcifer Hebard, 1924
Proc. Acad. nat. Sci. Philad. **76**: 119, pl. 5, figs. 5–6

PARATYPE: T3356, ♂; Ventura, E. Equador, iv.12.1922, (G. H. Tate), 1400 ft. (Specimen on a point.)

Anaplecta hemiscotia Hebard, 1919
Mem. Amer. ent. Soc. **4**: 20, pl. 2, fig. 8

PARATYPE: T3357; Trinidad Riv., Pan May, 3.11 August, Busc. (Specimen on a point.)

Cariblatta fossicauda Hebard, 1916
Trans. Amer. ent. Soc. **42**: 177, pl. 11, figs. 13–17, pl. 12, figs. 17–18

PARATYPES: T3353; 2 specimens from Caparo, Trinidad, –.viii.1913, S. M. Klages.

Dendroblatta sobrina Hebard, 1919
Mem. Amer. ent. Soc. **4**: 31, pl. 2, figs. 12–13

PARATYPE: T3355; Old Panama, Panama, xi.13.1913, Morgan Hebard. (Left wings spread and glued to a card pushed tight against ventral surface of specimen.)

Epilampra cinnamomea Hebard, 1926
Proc. Acad. nat. Sci. Philad. **78**: 202, pl. 11, fig. 4

PARATYPES: T3348; 2 specimens, St Jean du Muroni, Guyane Francse, Collection Le Mount. (Both have damaged legs.)

Euphyllodromia chopardi, Hebard
Proc. Acad. nat. Sci. Philad. **73**: 202, pl. 15, figs. 1–2

PARATYPE: T3349, ♀; Bartica, British Guiana, H. S. Parish, ii.12.1911.

Eurycotis biolleyi Rehn, 1918
Trans. Amer. ent. Soc., **44**: 321, pl. 18, figs. 1–4

PARATYPE: T7029; Pacayas, 1430 M[etres], Costa Rica, –.iv.1906, P. Biolley. (Left fore leg, right hind leg and left hind tarsus absent.)

Hyporhicnoda metae Hebard, 1921
Trans. Amer. ent. Soc., **47**: 138, pl. 10, figs. 29–30

PARATYPE: T3347; Villavicensio, Columbia, A. Maria, –.xii.1918. (Left mid and left hind legs absent.)

Ischnoptera panamae Hebard, 1919
Mem. Amer. ent. Soc. **4**: 77, pl. 4, figs. 14–15

PARATYPE: T3350; Old Panama, Panama, xi.13.1913, Morgan Hebard. (Left wings spread and glued to a card pushed tight against ventral surface of specimen.)

Jacobsonina simplex Hebard, 1929
Proc. Acad. nat. Sci. Philad. **81**: 57, pl. 4, figs. 1–2

PARATYPES: T3354, 1 ♂, 1 ♀; Fort de Kock (Sumatra) 920 M., Mei, 1921, leg. E. Jacobson.

Lophoblatta arawaka Hebard, 1929
Trans. Amer. ent. Soc. **55**: 350, pl. 13, figs. 6–7

PARATYPES: T3351; 3 specimens, Caparo, Trinidad –.viii.1913, S. M. Klages.

Mallotoblatta obscura Shelford, 1906
Trans. R. ent. Soc. Lond. 1909: 234

SYNTYPE(?): T7028, 1 specimen labelled as a cotype from Madras, (India). (Mounted on a micropin and staged on a card, left hind wing separated, spread and glued to the card stage; two red-edged labels are present on the pin, both as follows: 'Cotype, E. Shelford, *Mallotoblatta obscura*, T.E.S. Lond., 1906, p. 234'.)

Neoblattella fratercula Hebard, 1916
Ent. News **27**: 159, figs. 1–2

PARATYPE: T3352; Isla de Cocos, Costa Rica, –.i.1902, P. Biolley.

Panchlora cahita Hebard, 1922
Trans. ent. Soc. Amer. **48**: 174, pl. 7, fig. 1

PARATYPE: T3358; Venvidio, Sinaloa, Mexico, viii.25.1918 (J. A. Kusche). (Minus some legs.)

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CHELICERATE TYPE-SPECIMENS IN THE QUEENSLAND MUSEUM

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ABSTRACT

The Chelicerate type collection in the Queensland Museum comprises 14 Opiliones species, 80 Acari (19 ticks and 61 mites), 36 Aranea, and one species of Pycnogonida.

Types in the Queensland Museum arachnid collection have been variously treated since they began to accumulate in the last decade of the nineteenth century. In 1912 a general register of invertebrates (prefix G) was started and arachnid types acquired after that date were accessioned in that register. In 1914 a register of Crustacea and Arachnids (prefix W) was begun and an attempt was made to accession the material acquired before 1912. Types received up to 1963 have been entered in one or the other register. All arachnid types acquired since then are accessioned in the 'W' register.

Species are arranged in this list alphabetically within genera, and genera similarly within orders.

The criteria used to determine whether or not a specimen is a type are similar to those of Covacevich, 1971. All specimens bore some label to the effect that they were types. Not all were registered.

CHELICERATA

OPILIONES

Specimens are stored in 75% alcohol with glycerine, in tubes, in screw top jars, except as noted. All are in good condition.

Austribalonius horridus Forster, 1955
Aust. J. Zool. **3**: 377–9

HOLOTYPE: W1910, ♀, Cardwell Ra., south side, NE. Q., T. E. Woodward, 2.vi.1953.

Austropsopolio novaehollandiae Forster, 1955
Aust. J. Zool. **3**: 358–9

HOLOTYPE: W1913, ♀ imm., Mt Hobwee, Lamington Plateau, SE. Q., ex leafmould, T. E. Woodward, 27.viii.1953. (Right pedipalp on slide.)

Bogania granulata Forster, 1955
Aust. J. Zool. **3**: 375–7

PARATYPES: W1903–4, 2 specimens, Bogan R., N.S.W., J. W. T. Armstrong, August 1952.

Cluniella distincta Forster, 1955
Aust. J. Zool. **3**: 384–6

HOLOTYPE: W1895, ♂, Mt Hobwee, Lamington Plateau, SE. Q., T. E. Woodward, 27.vii.1953.

ALLOTYPE: W1896, ♀, same data.

Cluniella minuta Forster, 1955
Aust. J. Zool. **3**: 383–4

HOLOTYPE: W1893, ♂, E. spur Mt Clunie, SE. Q., ex rain forest leafmould, T. E. Woodward, 5.iv.1953.

ALLOTYPE: W1894, ♀, same data.

Cluniella ornata Forster, 1955
Aust. J. Zool. **3**: 386–7

HOLOTYPE: W1891, ♂, near Curtis Falls, Mt Tambourine, SE. Q., ex rain forest leafmould, T. E. Woodward, 8.v.1953.

ALLOTYPE: W1892, ♀, same data.

Lomanella parva Forster, 1955
Aust. J. Zool. **3**: 390–2

HOLOTYPE: W1897, ♂, Wallaby Beach, Port Davey, SW. Tasmania, ex leafmould, E. N. Marks, 29.i.1954. (Genitalia on slide.)

ALLOTYPE: W1898, ♀, same data.

Monoxyomma rotundum Forster, 1955
Aust. J. Zool. **3**: 398–400

HOLOTYPE: W1911, ♂, National Park, SE. Q., J. L. Groom, 6.xii.1936.

ALLOTYPE: W1912, ♀, same data.

Rakaia woodwardi Forster, 1955
Aust. J. Zool. **3**: 355–7

HOLOTYPE: W1960, ♂, Clump Point, NE. Q., ex leafmould, T. E. Woodward, 3.vi.1953.

ALLOTYPE: W1961, ♀, same data.

Triaenobunus groomi Forster, 1955
Aust. J. Zool. **3**: 408–10

HOLOTYPE: W1905, ♂, National Park, SE. Q., J. L. Groom, 6.xii.1936.

ALLOTYPE: W1906, ♀, same data.

Triaenobunus minutus Forster, 1955
Aust. J. Zool. **3**: 402–4

HOLOTYPE: W1907, ♂, Binna Burra, SE. Q., ex leafmould, T. E. Woodward, 4.ix.1952.

ALLOTYPE: W1908, ♀, same data.

Triaenobunus woodwardi Forster, 1955
Aust. J. Zool. **3**: 405–6

HOLOTYPE: W1909, ♀, Mt Tambourine, on E. side below Eagle Point, SE. Q., ex leafmould, T. E. Woodward, 8.v.1953.

Zalmoxis cardwellensis Forster, 1955
Aust. J. Zool. **3**: 371–3

HOLOTYPE: W1901, ♂, Cardwell Ra., NE. Q., ex leafmould, T. E. Woodward, 2.vi.1953.

ALLOTYPE: W1902, ♀, same data.

Zalmoxis insulae Forster, 1955
Aust. J. Zool. **3**: 373–5

HOLOTYPE: W1899, ♂, Dauan Is., Torres St, E. N. Marks, 6.v.1953.

ALLOTYPE: W1900, ♀, same data.

ACARINA

Specimens are slide preparations (mites) or preserved in 75% alcohol with glycerine, in tubes, in screw top jars (ticks). All specimens are in good condition.

In four cases type material from two species shares the one slide. These are:

(1) Holotype *Guntherana petulans* G2489, four paratypes *G. rex* G2490–3.

(2) Holotype *Laelaps habrus* G2399, paratype *L. habrus* W3555, holotype *Trichosurolaelaps emanulae* G2398, paratype *T. emanulae* W3559.

(3) Paratype *Laelaps habrus* G2401, two paratypes *Trichosurolaelaps emanulae* G2400, W3560.

(4) Holotype *Trigonuropoda terraereginae* G2383, three paratypes *Urodiaspis novaehollandiae* W3566–8.

Amblyomma echidnae Roberts, 1953
Aust. J. Zool. **1**: 158–60

HOLOTYPE: W2117, ♀, Oonoonba, Townsville, NE. Q., on *Tachygolssus aculeatus*, C. R. Mulhearn, June, 1943.

Amblyomma macropi Roberts, 1953
Aust. J. Zool. **1**: 153–5

HOLOTYPE: W2114, ♂, Ingham, NE. Q., on kangaroo, 8.x.1917.

Amblyomma moyi Roberts, 1953
Aust. J. Zool. **1**: 151–3

HOLOTYPE: W2112, ♀, in kangaroo cave, Mt Isa, NW. Q., S.I. May, October, 1940.

PARATYPE: W2113, ♀, same data.

Both these females were found in the one tube. They were separated by the author's criterion 'In the paratype, the porose areas . . . with a narrower interval'.

Amblyomma sternae Roberts, 1953
Aust. J. Zool. **1**: 155–8
(= *Amblyomma loculosum* Neumann after Roberts, 1964, p. 306)

HOLOTYPE: W2115, ♂, Green Is., NE. Q., on *Sterna fuscata*, August 1941.

ALLOTYPE: W2116, ♀, same data.

Amblyomma triguttatum ornatissimum Roberts, 1962
Aust. J. Zool. **10**: 376–8

HOLOTYPE: G2558, ♀, Barrow Is., W.A., found in soil K. G. Butler, 19.ix.1958.

ALLOTYPE: G2559, ♂, same data.

Amblyomma triguttatum queenslandensis Roberts, 1962
Aust. J. Zool. **10**: 375–6

Holotype: G2556, ♀, Burketown, NW. Q., on dog, F. H. S. Roberts, 4.ix.1933.

Allotype: G2557, ♂, same data.

Amblyomma triguttatum rosei Roberts, 1962
Aust. J. Zool. **10**: 378–9

Holotype: G2554, ♀, Alice Springs district, N.T., on cattle, A. L. Rose, 17.ix.1953.

Allotype: G2555, ♂, same data.

Anoetostoma domrowi Fain, 1968
Proc. Linn. Soc. N.S.W. **92**: 246–8

Paratypes: W2192, W3545, 2 deutonymphs, Butemu village, Finisterre Ra. (4200′) Madang Central District, New Guinea, attached around base of abdomen of *Scoliophthalmus* nr *micans*, R. Pullen, October 1964.

Aponomma pulchrum Roberts, 1953
Aust. J. Zool. **1**: 140–2

Holotype: W2089, ♂, Rockhampton, NE. Q., on *Varanus* sp., 8.ii.1906.

Allotype: W2090, ♀, same data.

The label with these specimens carries the name *Amblyomma pulchrum*. Kaufman (pers. com.) agrees that these are the types of *Aponomma pulchrum* Roberts, 1953, and has placed a label in the tube to this effect.

Aponomma tachyglossi Roberts, 1953
Aust. J. Zool. **1**: 126–8
(= *Aponomma hydrosauri* (Denny), after Roberts, 1970, p. 118)

Holotype: W2109, ♀, Wowan, M.E.Q., on *Tachyglossus aculeatus*, J. W. Mackay, 10.vi.1937.

Paratypes: W1576, ♀, Monto, SE. Q., coll. P. K. Smith, 8.vi.1943. W2110, ♀, Boompa, Q., on *Tachyglossus* sp., 2.viii.1948.

Morphotypes: W2111, larvae bred from paratype W2110.

?Morphotypes: W3541, larvae found with type series.

Aponomma tropicum Roberts, 1953
Aust. J. Zool. **1**: 128–9
(= *Aponomma concolor* Neumann after Roberts, 1964, p. 291)

Holotype: W2091, ♀, Dunk Is., NE. Q., on 'Albino echidna' (QM J5985), H. Brassey, 7.ix.1936. (Previously registered as W671.)

Paratypes: W2092–108, 17 ♀, same data. (Previously registered as W671.)

Twenty-one specimens from an albino echidna were registered as W671 on 7.ix.1936. Roberts referred to his holotype as W6.71 and gave 25.viii.1936 as date of collection. He mentions 21 paratypes, collected on 15.x.1936. As all specimens were taken from an albino echidna there is no doubt that they were part of W671 in spite of the discrepancy in dates. In 1964 only 18 of these specimens were in the collections. One of these, labelled holotype, was reregistered as W2091; the remaining 17, labelled paratypes, were reregistered as W2092–108.

Ascoschongastia (Oculicola) scaevola Domrow, 1960c
Stud. Inst. Med. Res. F.M.S. **29**: 182–4

Holotype: G2457, larva, Mena Ck, near Innisfail NE. Q., loose among tears of left eyeball of *Hydromys chrysogaster*, J. L. Harrison, 27.vi.1958.

Paratype: G2458, larva, same data.

Atellana papilio Domrow, 1958b
Proc. Linn. Soc. N.S.W. **83**: 43–4

HOLOTYPE: G2404, ♂, D'Aguilar Ra., SE. Q., from rump fur of *Trichosurus vulpecula*, R. Domrow, 1.iv.1957.

ALLOTYPE: G2405, ♀, same data.

MORPHOTYPE: W3573, nymph, same data.

Austrochirus dycei Domrow, 1960a
Acarologia **2**: 97–100

HOLOTYPE: G2440, ♂, Weetangera Rd., A.C.T., on *Trichosurus vulpecula*, A. L. Dyce, 28.x.1958.

ALLOTYPE: G2441, ♀, same data.

Austrochirus enoplus Domrow, 1956b
Proc. Linn. Soc. N.S.W. **80**: 237–9

HOLOTYPE: G2411, ♀, Flyingfish Point, NE. Q., on *Hydromys chrysogaster reginae*, R. Domrow, 18.v.1955.

ALLOTYPE: G2417, ♂, same data.

Austrochirus filmeri Domrow, 1960a
Acarologia **2**: 94–7

HOLOTYPE: G2442, ♂, Birdsville, SW. Q., in rump fur of *Macrotis lagotis*, I. G. Filmer, July, 1958.

ALLOTYPE: G2443, ♀, same data.

Austrochirus perkinsi Domrow, 1958b
Proc. Linn. Soc. N.S.W. **83**: 41–3

HOLOTYPE: G2402, ♀, Lone Pine Sanctuary, Brisbane, SE. Q., on *Phascolarctos cinereus*, F. A. Perkins, 26.ix.1955.

ALLOTYPE: G2403, ♂, same data.

Austrochirus trouessarti Domrow, 1961
Proc. Linn. Soc. N.S.W. **86**: 86–8

HOLOTYPE: G2484, ♀, Palmerston National Park, NE. Q., on *Antechinus flavipes godmani* in rainforest at 1200′, R. Domrow, 18.iii.1959.

ALLOTYPE: G2485, ♂, Palmerston National Park, NE. Q., on *Antechinus flavipes godmani* in rainforest at 1200′, R. Domrow, 10.vi.1960.

Austrogamasellus camini Domrow, 1957
Proc. Linn. Soc. N.S.W. **81**: 204

HOLOTYPE: G2338, ♀, Low Is., NE.Q., in leaf mould, E. N. Marks, 14.viii.1954.

Bdellodes pacifica Atyeo, 1963
Bull. Univ. Neb. St. Mus. **4**: 183–5

HOLOTYPE: G2563, ♂, Low Is., on beach rock exposed as tide recedes on south side of island, NE. Q., E. N. Marks, 19.viii.1954.

?PARATYPE: G2537, tritonymph, same data. (Examined by Atyeo at time of description but not designated paratype.)

Bewsiella fledermans Domrow, 1958a
Proc. Linn. Soc. N.S.W. **82**: 353

HOLOTYPE: G2406, ♀, Lockhart River Mission, Cape York, on *Hipposideros cervinus*, M. J. Mackerras, 13.vi.1956.

PARATYPE: W3544, ♀, same data.

Domrow (1959, pp. 233–4) subsequently designates an 'Allotype', W2010. The slide bears the name '*Bewiella*'.

Cosmolaelaps multisetosus Domrow, 1957
Proc. Linn. Soc. N.S.W. **81**: 209

HOLOTYPE: G2352, ♀, Low Is., NE. Q., in leaf mould, E. N. Marks, 14.viii.1954.

ALLOTYPE: G2353, ♂, same data.

PARATYPES: G2354, W3546, 2 ♀.

Cytostethum charactum Domrow, 1956a
Proc. Linn. Soc. N.S.W. **80**: 194–6

HOLOTYPE: G2412, ♀, Mt Nebo, SE. Q., on *Potorous tridactylus*, R. Domrow, 24.ix.1954.

PARATYPES: W3547–8, 2 ♀, same data.

MORPHOTYPES: W3549–50, 2 larvae, same data.

Cytostethum clibanarius Domrow, 1961
Proc. Linn. Soc. N.S.W. **86**: 90–2

HOLOTYPE: G2468, ♀, near Herberton, NE. Q., on *Aepyprymnus rufescens* found dead on road, R. Domrow, 9.iv.1959.

ALLOTYPE: G2469, ♂, same data.

PARATYPES: G2470, ♂; G2471, ♀, same data.

Cytostethum moschati Domrow, 1961
Proc. Linn. Soc. N.S.W. **86**: 93–4

HOLOTYPE: G2465, ♂, Dinner Ck, near Innisfail, NE. Q., on *Hypsiprymnodon moschatus* caught in rainforest, J. L. Harrison, 4.viii.1960.

ALLOTYPE: G2464, ♀, Dinner Ck, near Innisfail, NE. Q., on *Hypsiprymnodon moschatus* caught in rainforest, J. L. Harrison, 30.vi.1960.

Cytostethum nanophys Domrow, 1956a
Proc. Linn. Soc. N.S.W. **80**: 196–7

HOLOTYPE: G2413, ♀, Mt Nebo, SE. Q., on *Potorous tridactylus*, R. Domrow, 24.ix.1958.

PARATYPE: W3408, ♀, same data.

Cytostethum parvum Domrow, 1961
Proc. Linn. Soc. N.S.W. **86**: 92–3

HOLOTYPE: G2466, ♂, Dinner Ck., near Innisfail, NE. Q., on *Hypsiprymnodon moschatus* caught in rainforest, J. L. Harrison, 30.vi.1960.

PARATYPE: G2467, ♂, same data.

Neither specimen is marked as Holotype.

Cytostethum promeces Domrow, 1956a
Proc. Linn. Soc. N.S.W. **80**: 193

HOLOTYPE: G2414, ♀, Mt Nebo, SE. Q., on *Potorous tridactylus*, R. Domrow, 24.ix.1954.

PARATYPES: W3551–4, 4 ♀, same data.

Cytostethum pseudocharactum Domrow, 1956a
Proc. Linn. Soc. N.S.W. **80**: 196

HOLOTYPE: G2415, ♀, Mt Nebo, SE. Q., on *Potorous tridactylus*, R. Domrow, 24.ix.1954.

Domrow (1961, p. 88) subsequently designates a male 'Allotype', G2472, and two 'Paratypes', G2473 and G2474.

Cytostethum trachypyx Domrow, 1956a
Proc. Linn. Soc. N.S.W. **80**: 194

HOLOTYPE: G2416, ♀, Mt Nebo, SE.Q., on *Potorous tridactylus*, R. Domrow, 24.ix.1954.

Depranonychus hapsis Davies, 1969c
Mem. Qd Mus. **15**: 166–70

HOLOTYPE: W2794, ♀, 5·4 miles W. of Kilkivan by Tasey Road, on *Eucalyptus melanopholia*, J. J. Davies, 29.ix.1965.

ALLOTYPE: W2795, ♂, same data.

PARATYPE: W2796, ♂, 5·4 miles W. of Kilkivan by Tasey Road, on *Eucalyptus melanopholia*, J. J. Davies, 17.ii.1966.

Discozercon derricki Domrow, 1956c
Proc. Linn. Soc. N.S.W. **81**: 193–5

HOLOTYPE: W1973, ♂, Mt Tamborine, SE. Q., on *Scolopendra* sp., E. H. Derrick, 24.ii.1954. Specimen intact, slide broken.

Echinonyssus validipes Domrow, 1955
Proc. Linn. Soc. N.S.W. **80**: 133–6

HOLOTYPE: G2409, ♀, Mt Nebo, SE. Q., on *Potorous tridactylus*, R. Domrow, 24.ix.1954.

ALLOTYPE: G2410, ♂, same data.

Eotetranychus lomandrae Davies, 1968b
Qd J. Agric. Anim. Sci. **25**: 69–72

HOLOTYPE: W2533, ♂, Palmwoods, SE. Q., on *Lomandra longifolia*, D. A. Ironside, 13.v.1966.

ALLOTYPE: W2534, ♀, same data.

PARATYPE: W2535, ♀, same data.

Eotetranychus pronus Davies, 1969c
Mem. Qd Mus. **15**: 171–4

HOLOTYPE: W2828, ♂, Skyring Ck, near Pomona, SE. Q., on *Ficus coronata*, J. J. Davies, 7.ii.1966.

ALLOTYPE: W2829, ♀, same data.

Eotetranychus pseudomori Davies, 1969c
Mem. Qd Mus. **15**: 174–7

HOLOTYPE: W2792, ♂, Lower Wonga, junction of Wonga and Widgee Cks, 12 miles NW. Gympie, SE. Q., on *Pseudomorus brunoniana*, J. J. Davies, 10.iii.1967.

ALLOTYPE: W2793, ♀, same locality and host, 10.iii.1965.

Epicroseius porosus Domrow, 1957
Proc. Linn. Soc. N.S.W. **81**: 197–200

HOLOTYPE: G2313, ♂, Green Ant Is., Low Is., NE. Q., under rotting log, E. N. Marks and M. J. Mackerras, 14.viii.1954.

ALLOTYPE: G2314, ♀, same data.

PARATYPES: G2315, ♂, G2316, ♀, Low Is., NE. Q., in leaf mould on cay, E. N. Marks, 19.viii.1954.

MORPHOTYPES: G2319, nymphs, Green Ant Is., Low Is., NE. Q., in leaf mould, E. N. Marks, 24.viii.1954. G2317, nymph; G2318, 2 nymphs; G2320, nymph, Low Is., NE. Q., in leaf mould, E. N. Marks, 19.viii.1954.

Eutrachytes simplicior Domrow, 1957
Proc. Linn. Soc. N.S.W. **81**: 209–11

HOLOTYPE: G2358, ♂, Green Ant Is., Low Is., NE. Q., under rotting log, E. N. Marks and M. J. Mackerras, 14.viii.1954.

ALLOTYPE: G2359, ♀, same data.

PARATYPES: G2361, gnathosoma, Low Is., NE. Q., E. N. Marks and M. J. Mackerras, August 1954. G2362, chelicerae, same data.

MORPHOTYPES: G2360, nymphs, Low Is., E. N. Marks and M. J. Mackerras.

Gamasiphis mackerrasae Domrow, 1957
Proc. Linn. Soc. N.S.W. **81**: 202–3

HOLOTYPE: G2339, ♀, Low Is., NE. Q., in leaf mould, E. N. Marks, 19.viii.1954.

ALLOTYPE: G2340, ♂, Green Ant Is., Low Is., NE. Q., in leaf mould, E. N. Marks, 24.viii.1954.

PARATYPES: G2341–3, 4 ♂; G2344, ♂ and ♀, Low Is., NE. Q., in leaf mould, E. N. Marks, 19.viii.1954. G2345, 8 unsexed, Green Ant Is., Low Is., NE. Q., in leaf mould, E. N. Marks, 24.viii.1958.

Guntherana emphyla Domrow, 1960b
Pacific Insects **2**: 217–9

HOLOTYPE: G2486, larva, Innisfail, NE. Q., from ear of *Isoodon macrourus*, J. L. Harrison, 29.viii.1958.

Guntherana pannosa Domrow, 1960b
Pacific Insects **2**: 225–7

HOLOTYPE: G2487, larva, Coorumba, near Innisfail, NE. Q., on *Rattus assimilis* collected in farmland, J. L. Harrison, 15.vii.1958.

Guntherana petulans Domrow, 1960b
Pacific Insects **2**: 202–4

HOLOTYPE: G2489, larva, Etty Bay Rd, near Innisfail, NE. Q., from anogenital region of *Rattus assimilis* collected in savannah country, J. L. Harrison, 25.vii.1958.

Guntherana rex Domrow, 1960b
Pacific Insects **2**: 212–4

HOLOTYPE: G2488, larva Mena Ck, near Innisfail, NE. Q., on *Rattus assimilis* collected in farmland, J. L. Harrison, 8.vii.1958.

PARATYPES: G2490–3, 4 larvae, Etty Bay Rd, near Innisfail, NE. Q., from anogenital region of *Rattus assimilis* collected in savannah country, J. L. Harrison, 25.vii.1958.

Guntherana taylorae Domrow, 1962
Treubia **26**: 45–6

HOLOTYPE: G2533, larva, Pearl Beach, N.S.W. on *Rattus assimilis*, B. E. Horner and J. M. Taylor, 9.viii.1955.

Haemolaelaps machaeratus Domrow, 1957
Proc. Linn. Soc. N.S.W. **81**: 207

HOLOTYPE: G2347 (body), G2348 (legs), ♀, Green Ant Is., Low Is., NE. Q., in leaf mould, E. N. Marks, 24.viii.1954.

Haemolaelaps ulysses Domrow, 1961
Proc. Linn. Soc. N.S.W. **86**: 63–4

HOLOTYPE: G2461, ♀, Warramate Hills near Lilydale, Victoria, on ear of *Pseudochiris perigrinus laniginusus*, J. A. Thompson, 17.vii.1960 (1).

Haemaphysalis bremneri Roberts, 1963
Aust. J. Zool. **11**: 49–53

HOLOTYPE: G2562, ♂, Moggill, SE. Q., bred from nymph found on *Trichosurus vulpecula*, K. C. Bremner, 2.ix.1958.

ALLOTYPE: G2563, ♀, same data.

Haemaphysalis petrogalis Roberts, 1970
'Australian Ticks' (C.S.I.R.O.: Melbourne), pp. 74–6.

HOLOTYPE: W3501, ♂, Magnetic Is., NE. Q., on *Petrogale penicillata inornata*, K. Keith, 9.xi.1966.

ALLOTYPE: W3502, ♀, same data.

Hypoaspis womersleyi Domrow, 1957
Proc. Linn. Soc. N.S.W. **81**: 205–7

HOLOTYPE: G2349, ♀, Low Is., NE. Q., in leaf mould, E. N. Marks, 14.viii.1954.

ALLOTYPE: G2350 (body), G2351 (fragments), ♂, same data.

Ichoronyssus aristippe Domrow, 1959
Proc. Linn. Soc. N.S.W. **83**: 228–90

HOLOTYPE: W2008, ♀, Teviotbrook, SE. Q., from rump fur of *Miniopterus schreibersii blepotis*, R. Domrow, 10.x.1957.

MORPHOTYPE: W2009, nymph, same data.

Ichoronyssus leucippe Domrow, 1959
Proc. Linn. Soc. N.S.W. **83**: 227–8

HOLOTYPE: W2007, ♀, Yandina, SE. Q., from rump fur of *Miniopterus schreibersii blepotis*, R. Domrow, 10.iv.1958.

Ixodes confusus Roberts, 1960
Aust. J. Zool. **8**: 460–5

HOLOTYPE: G2456, ♂, Sogeri, Papua, on 'wallaby', J. Barrett, July 1953.

ALLOTYPE: G2455, ♀, Sogeri, Papua, on 'wallaby', J. Barrett, 7.xii.1951.

Laelaps breviseta Domrow, 1961
Proc. Linn. Soc. N.S.W. **86**: 65–7

HOLOTYPE: G2481, ♀, Dinner Ck, near Innisfail, NE. Q., on *Rattus assimilis* in rainforest, J. L. Harrison, 23.ix.1959.

Laelaps habrus Domrow, 1958a
Proc. Linn. Soc. N.S.W. **82**: 365

HOLOTYPE: G2399, ♀, Gona, Papua, on *Echymipera kalabu kalabu* in rainforest, R. Domrow, 6.xii.1956.

PARATYPES: G2401, W3555, 2 ♀, same data.

Laelaps mackerrasi Domrow, 1961
Proc. Linn. Soc. N.S.W. **86**: 70–1

HOLOTYPE: G2475, ♀, Dinner Ck, near Innisfail, NE. Q., on *Rattus assimilis* in rainforest, J. L. Harrison, 10.vi.1959.

PARATYPES: G2476–80, 5 ♀, same data.

Laelaps southcotti Domrow, 1958a
Proc. Linn. Soc. N.S.W. **82**: 364–5

HOLOTYPE: G2407, ♀, Etty Bay, NE. Q., on *Uromys caudimaculatus*, R. Domrow, 20.iii.1956.

PARATYPE: W3556, ♀, same data.

Laelaps wasselli Domrow, 1958a
Proc. Linn. Soc. N.S.W. **82**: 363

HOLOTYPE: G2408, ♀, Innisfail, NE. Q., on *Hydromys chrysogaster reginae*, R. Domrow, 6.ix.1956.

Marsuiops trichosuri Fain, 1968
Proc. Linn. Soc. N.S.W. **92**: 249–50

PARATYPES: W2913, W3557–8, 3 deutonymphs, Weetangera Rd, A.C.T., in hair follicles of ears and tail of *Trichosurus vulpecula*, A. C. Dyce, 28.x.1958.

Neotetranychus victoriae Davies, 1969d
Mem. Qd Mus. **15**: 185–9

HOLOTYPE: W2951, ♀, The Basin, Dandenong Ra., Victoria, on *Spyridium parvifoium*, J. J. Davies, 10.i.1967.

ALLOTYPE: W2952, ♂, same data.

PARATYPE: W2953, ♀, same data.

Notonychus asper Davies, 1969a
J. Aust. Ent. Soc. **8**: 103–6

HOLOTYPE: W3042, ♀, Boat Mountain, near Murgon, SE. Q., on *Gahnia asper*, J. J. Davies, 29.iv.1968.

Oligonychus areneum Davies, 1968a
J. Aust. Ent. Soc. **7**: 123–6

HOLOTYPE: W3025, ♂, Mapleton, SE. Q., on *Pennisetum clandestinum*, J. J. Davies, 1.xii.1966.

ALLOTYPE: W3026, ♀, same data.

Oligonychus digitatus Davies, 1966
Qd J. Agric. Anim. Sci. **3**: 569–72

HOLOTYPE: W2496, ♂, Ipswich, SE. Q., on *Digitaria didactyla*, J. H. Barrett, 27.x.1964.

ALLOTYPE: W2497, ♀, same data.

Pneumonyssus dentatus Domrow, 1961
Proc. Linn. Soc. N.S.W. **86**: 73–5

HOLOTYPE: G2459, nymph, Palmerston National Park, NE. Q., in nasal passages of *Antechinus flavipes godmani* in rainforest at 1200′, J. L. Harrison, 10.vi.1960.

PARATYPE: G2460, nymph, same data.

Radfordia fanningi Domrow, 1963
J. Ent. Soc. Qd **2**: 13–14

HOLOTYPE: G2551, ♀, Dayman Pt. NE. Q., on *Melomys lutillus*, G. Barrow, 31.viii.1962.

ALLOTYPE: G2552, ♂, Mowbray, NE. Q., on *Melomys lutillus*, G. Barrow, 5.vii.1962.

Rhodacarus marksae Domrow, 1957
Proc. Linn. Soc. N.S.W. **81**: 200

HOLOTYPE: G2322, ♀, Green Ant Is., Low Is., NE. Q., in leaf mould, E. N. Marks, 24.viii.1954.

Schizotetranychus gahniae Davies, 1969b
J. Aust. Ent. Soc. **8**: 107–9

HOLOTYPE: W3040, ♂, Boat Mountain, near Murgon, SE. Q., on *Gahnia asper*, J. J. Davies, 17.x.1967.

ALLOTYPE: W3041, ♀, same data.

Schizotetranychus russeus Davies, 1969c
Mem. Qd Mus. **15**: 177–9

HOLOTYPE: W2824, ♂, Palmwoods, SE. Q., on *Lomandra multiflora*, J. J. Davies, 11.x.1966.

ALLOTYPE: W2825, ♀, same data.

Schizotetranychus sagatus Davies, 1969c
Mem. Qd Mus. **15**: 179–82

HOLOTYPE: W2826, ♂, Atherton, NE. Q., on *Themeda australis*, R. J. Elder, 10.x.1966.

ALLOTYPE: W2827, ♀, same data.

Teinocoptes domrowii Fain, 1961
Proc. Linn. Soc. N.S.W. **85**: 268–72

HOLOTYPE: G2449, ♀, Mundoo, N.Q., on *Pteropus conspicillatus*, J. L. Harrison, 29.vi.1959.

PARATYPES: G2450–1, 2 ♀, same data.

MORPHOTYPES: G2452–4, 3 larvae, same data.

Tetranychus dianellae Davies, 1967
Qd J. Agric. Anim. Sci. **24**: 201–5

HOLOTYPE: W2495, ♂, Perwillowen, via Nambour, SE. Q., on *Dianella cerulae*, D. A. Ironside, 5.vii.1966.

ALLOTYPE: W2494, ♀, same locality and host, 27.vii.1966.

PARATYPE: W2488, ♀, same data as holotype.

Trichosurolaelaps emanuelae Domrow, 1958a
Proc. Linn. Soc. N.S.W. **82**: 355–6

HOLOTYPE: G2398, ♀, Gona, Papua, on *Echymipera kalabu kalabu* in forest, R. Domrow, 6.xii.1956.

PARATYPES: W3559, ♀; G2400, W3560, 2 ♂, same data.

Trichosurolaelaps harrisoni Domrow, 1961
Proc. Linn. Soc. N.S.W. **86**: 78–81

HOLOTYPE: G2462, ♀, Dinner Ck, near Innisfail, NE. Q., on *Hypsiprymnodon moschatus* in rainforest, J. L. Harrison, 30.vi.1960.

ALLOTYPE: G2463, ♂, same data.

Trichosurolaelaps striatus Domrow, 1958a
Proc. Linn. Soc. N.S.W. **82**: 356–8

HOLOTYPE: G2396, ♀, Mt Nebo, SE. Q., on *Pseudocheirus laniginosus*, R. Domrow, 29.x.1954.

ALLOTYPE: G2397, ♂, Brisbane, SE. Q., on *Pseudocheirus laniginosus*, R. Domrow, 10.iv.1957.

PARATYPES: W3561–2, 2 ♀, same data as holotype. W3563, ♂, same data as allotype.

Trigonuropoda terraereginae Domrow, 1957
Proc. Linn. Soc. N.S.W. **81**: 213–4

HOLOTYPE: G2383, ♀, Low Is., NE. Q., in leaf mould, E. N. Marks and M. J. Mackerras, 19.viii.1954.

ALLOTYPE: G2384, ♂, same data.

PARATYPES: W3564–5, 2 ♂, same data. G2385, 6 unsexed, G2386, 14 unsexed, G2387, 7 unsexed, G2388, 15 unsexed, G2389, 14 unsexed, same data.

MORPHOTYPES: 2 larvae, same data, one on slide G2388, other on G2389.

Trombicula alicota Domrow, 1961
Proc. Linn. Soc. N.S.W. **86**: 81

HOLOTYPE: G2482, larva, Bramston Beach, NE. Q., on *Rhinolophus megaphyllus* in cave, J. L. Harrison, 27.vii.1959.

PARATYPE: G2483, larva, same data.

Trombicula dasyphloea Domrow 1959
Proc. Linn. Soc. N.S.W. **83**: 235–6

HOLOTYPE: W2011, larva, Lockhart R. mission, N.Q., from perineum of *Hipposideros semoni*, M. J. Mackerras, 13.vi.1956.

PARATYPES: W2010, larva, same data.

Trombicula minor Berlese

'PARANEOTYPES': W3409–13, 5 slides of larval material, Kepong, Malaysia, on *Taphozous*, 1.v.1953. (Good.) (Designated by Audy et al., 1965, pp. 19–20.)

Trombigaster alcithoe Domrow, 1959
Proc. Linn. Soc. N.S.W. **83**: 237–8

HOLOTYPE: W2013, larva, Bramston Beach, NE. Q., from wing membrane of *Hipposideros bicolor albanensis*, R. Domrow, 13.xii.1957.

Urodiaspis novaehollandiae Domrow, 1957
Proc. Linn. Soc. N.S.W. **81**: 214–5

HOLOTYPE: G2397, ♀, Low Is., NE. Q., in leaf mould, E. N. Marks, 19.viii.1954.

ALLOTYPE: G2380, ♂, same data.

PARATYPES: W3566, ♂; W3567, W3568, 2 ♀, same data.

MORPHOTYPES: G2381–2, 2 nymphs, same data.

Zygoriblatula longiporosa Hammer, 1953
Aust. J. Zool. **1**: 236–8

SYNTYPES: W1854, W3569, 2 unsexed specimens, Yeerongpilly, Brisbane, SE. Q., in pasture, Lot 52-5629, F. H. S. Roberts, 14.v.1952.

ARANEIDA

Specimens are stored in spirit in the same manner as the Opiliones. The condition of each is given in parentheses at the end of each note.

The collection contains a number of specimens used by Rainbow when describing new species. Rainbow usually described one specimen of each sex available to him but often did not indicate the total number of specimens on which his species were based, and sometimes did not even say that there were specimens other than those described. That such specimens existed is shown by the presence in the collections of a number of specimens in a single jar labelled as Rainbow's Types when Rainbow mentioned only the one (or two) specimen(s) he described. These specimens must form part of the type series even though they were not mentioned in Rainbow's papers. In three cases (noted in list) a holotype was designated by a museum label, 'type', and paratypes by a museum label 'cotypes'. For the remaining Rainbow material, as no one specimen was ever referred to as 'the type' or by some equivalent expression, all specimens available to Rainbow and likely to have been used by him in formulating his concept of a new species must be regarded as syntypes (Art 73). In two cases it is possible to recognise the specimen described, this is indicated in the list.

Antrochares macgregori Rainbow, 1898
Proc. Linn. Soc. N.S.W. **23**: 332–3

HOLOTYPE: W3575, ♀, Neneba, New Guinea, A. Giulianetti, Nov. 1896. (Fragmentary.)

Rainbow's label bears the name *Antrochares* (gen. nov.) *novaeguineaensis* (sp. nov.), with the same data as appears in the published description of *A. macgregori*. Rainbow is known to have changed names in the manuscript stage (see *Diaea colcloughi*).

Araneus depressus Rainbow, 1898
Proc. Linn. Soc. N.S.W. **23**: 340–2

SYNTYPES: W3517, 3 ♀, Neneba, New Guinea, A. Giulianetti, 9.ix.1896. (Fair.)

Araneus notandus Rainbow, 1912a
Mem. Qd Mus. **1**: 196

HOLOTYPE: W2122, ♀, Blackall Ra., SE. Q., C. J. Wild. (Poor.)

Araneus transversus Rainbow, 1912a
Mem. Qd Mus. **1**: 197–8

SYNTYPES: W2123, ♂; W2126, ♀, Blackall Ra., C. J. Wild. (Fair.)

Archaea nodosa Forster, 1956
Mem. Qd Mus. **13**: 151–4

HOLOTYPE: W1955, ♀, Tallawallal, Lamington National Park, SE. Q., from moss near *Notofagus*, T. E. Woodward, 31.x.1955. (Fair.) Spirit specimen, right pedipalp and legs on slide. Slide not located 5.vii.1971.

Argentotenus devisi Rainbow, 1898
Proc. Linn. Soc. N.S.W. **23**: 350–1

HOLOTYPE: W3525, ♀, Tamatava Station, Mambare R., New Guinea, A. Giulianetti. (Poor.) (Designation by museum label.)

PARATYPE: W3526, ♀, same data. (Poor.)

Argyrodes argentiopunctata Rainbow, 1916b
Rec. Aust. Mus. **11**: 51–2

PARATYPES: W18, 1 ♂, 1 ♀, Gordonvale, NE. Q., A. A. Girault. (Fair.)

Argyrodes flavipes Rainbow, 1916b
Rec. Aust. Mus. **11**: 53

PARATYPES: W19, 1 ♂ and 1 ♀, Gordonvale, NE. Q., A. A. Girault. (Poor.)

Argyrodes nigronodosa Rainbow, 1912a
Mem. Qd Mus. **1**: 193–4

HOLOTYPE: W2124, ♂, Blackall Ra., SE. Q., L. J. Wild. (Fair.)

Attus albopilosus Rainbow, 1898
Proc. Linn. Soc. N.S.W. **23**: 352–4

HOLOTYPE: W3524, ♂, Tamatava Station, Mambara R., New Guinea, A. Giulianetti. (Poor.)

Bathyphantes montanus Rainbow, 1912a
Mem. Qd Mus. **1**: 194–5

HOLOTYPE: W2125, ♀, Blackall Ra., SE. Q., C. J. Wild. (Fair.)

Cataxia babindaensis Main, 1969
J. Aust. Ent. Soc. **8**: 203–5

HOLOTYPE: W3125, ♀, The Boulders National Park, Babinda, NE. Q., B. Y. Main, 11.viii.1965. (Good.)

Cataxia eungellaensis Main, 1969
J. Aust. Ent. Soc. **8**: 205–6

HOLOTYPE: W3126, ♀, creek crossing on road between Valley lookout and Broken R., Eungella National Park, NE. Q., B. Y. Main, 8.viii.1965.

PARATYPE: W3127, ♀, same data. (Good.)

Cataxia spinepectoris Main, 1969
J. Aust. Ent. Soc. **8**: 201–3

HOLOTYPE: W2876, ♀, Toowoomba, SE. Q., W. G. Earle, 13.ix.1961. (Good.)

PARATYPE: W2877, ♂, Toowoomba, SE. Q., D. K. O'Donnell, per. A. May, 23.vi.1950. (Fair.)

Chenistonia giraulti Rainbow, 1914
Rec. Aust. Mus. **10**: 243–7

PARATYPES: W22–3, 2 ♀, Nelson, NE. Q., A. A. Girault. (Fair.)

Clubiona giulianetti Rainbow, 1898
Proc. Linn. Soc. N.S.W. **23**: 348–50

SYNTYPES: W3527, 5 ♂ and 2 ♀, Neneba, New Guinea, A. Giulianetti, 9.ix.1896. (Fragmentary.)

Cyrtophora albopunctata Rainbow, 1898
Proc. Linn. Soc. N.S.W. **23**: 339–40

HOLOTYPE: W3516, ♀, Naneba, Mt Scratchley, 4,000′ to 5,000′, New Guinea, A. Giulianetti, November 1896. (Poor.)

Cyrtophora simonsi Rainbow, 1898
Proc. Linn. Soc. N.S.W. **23**: 337–9

SYNTYPES: W3508–15, 7 ♀, Neneba, Mt Scratchley, 4000′ to 5000′, New Guinea, A. Giulianetti, November 1896. (Fragmentary.)

W3508 recognised as the specimen described by Rainbow by his criterion—'largest of the series collected'.

Diaea colcloughi Rainbow, 1912b
Mem. Qd Mus. **1**: 205–6

HOLOTYPE: W2192, ♀, Roper R., N.T., M. J. Colclough. (Fair.)

Label with specimen says *Diaea quinquangulata* (type). Letter 12/977 from Rainbow to Hamlyn-Harris asks the latter to rename *quinquangulata* 'after one of your collectors. Cokeley was it not?' Hamlyn-Harris substituted *colcloughi*.

Diaea ocellata Rainbow, 1898
Proc. Linn. Soc. N.S.W. **23**: 344

HOLOTYPE: W3520, ♀, Neneba, New Guinea, A. Giulianetti, November 1896. (Poor.)

Dolomedis trux Lamb, 1911
Ann. Qd Mus. **10**: 173–4

HOLOTYPE: G55, ♀, Ithaca Ck, Brisbane, SE. Q. (Very poor.)

Dolophones bituberculata Lamb, 1911
Ann. Qd Mus. **10**: 172–3

HOLOTYPE: W2121, ♀, Stafford-on-Kedron, Brisbane, SE. Q., J. Lamb, November 1909. (Good.)

Gasteracantha quadrispina Lamb, 1911
Ann. Qd Mus. **10**: 171

HOLOTYPE: W2118, ♀, Eumundi, SE. Q. (Fair.)

Idiommata crassipes Rainbow, 1898
Proc. Linn. Soc. N.S.W. **23**: 329–30

HOLOTYPE: ♀, said by Rainbow, 1898, p. 328, to be in the QM collections. Specimen not located 12.x.1971.

Idiommata sordida Rainbow, 1898
Proc. Linn. Soc. N.S.W. **23**: 330–1

HOLOTYPE: W3503, ♀, Neneba, New Guinea, A. Giulianetti. (Poor.)

Macedonia octospinata Lamb, 1911
Ann. Qd Mus. **10**: 169–70

HOLOTYPE: W2119, ♀, Stafford-on-Kedron, Brisbane, SE. Q., J. Lamb, 6.v.1910. (Fair.)

Menemerus acuminatus Rainbow, 1912a
Mem. Qd Mus. **1**: 201–2

HOLOTYPE: W2127, ♀, Blackall Ra., SE. Q., L. J. Wild. (Fair.)

Meta argentiopunctata Rainbow, 1916c
Rec. Aust. Mus. **11**: 85–6

PARATYPES: W24, 2 ♀ and 2 ♂, Gordonvale, NE. Q., A. A. Girault, May 1913. (Fair.)

Misumena bipunctata Rainbow, 1898
Proc. Linn. Soc. N.S.W. **23**: 342–3

HOLOTYPE: W3519, ♀, Neneba, New Guinea, A. Giulianetti, 9.ix.1896. (Fair.)

Mollica juncunda Rainbow, 1912b
Mem. Qd Mus. **1**: 208–9

HOLOTYPE: W2139, ♀, Roper R., N.T., M. J. Colclough. (Good.) (Designation by museum label.)

PARATYPES: W2129–32, 4 ♀, same data. (Good.)

Nephila maculata piscatorum DeVis, 1911
Ann. Qd Mus. **10**: 167–8

HOLOTYPE: W2120, ♀, Dunk Is., NE. Q., E. J. Banfield. (Fair.)

Sarotes similaris Rainbow, 1898
Proc. Linn. Soc. N.S.W. **23**: 346–7

SYNTYPES: W3522–3, 2 ♀, Neneba, Mt Scratchley, 4000′ to 5000′, New Guinea, A. Giulianetti, July 1896. (Poor.)

Storena variepes Rainbow, 1912a
Mem. Qd Mus. **1**: 192–3

HOLOTYPE: W2128, ♀, Blackall Ra., SE. Q., C. J. Wild. (Fair.)

Tetragnatha lepida Rainbow, 1916c
Rec. Aust. Mus. **11**: 81–3

PARATYPES: W20, 1 ♂ and 1 ♀, Gordonvale, NE. Q., A. A. Girault. (Fair.)

Uloborus congeregabilis Rainbow, 1916a
Aust. Zool. **1**: 59–60

PARATYPES: W12, Parramatta, N.S.W., A. R. McCulloch, 11.i.1915. (Very fragmentary; two prosomas, one opisthosoma and one whole specimen.)

Uloborus flavolineatus Rainbow, 1898
Proc. Linn. Soc. N.S.W. **23**: 333–4

HOLOTYPE: W3504, ♀, Boirave, 1500′, New Guinea, A. Giulianetti, July 1896. (Fragmentary.) (Designation by museum label.)

PARATYPES: W3505–7, 3 ♀, same data. (Fragmentary.)

Holotype and one paratype in one tube, inseparable because of fragmented legs, holotype prosoma recognisable by measurements.

Xysticus obscurus Rainbow, 1898
Proc. Linn. Soc. N.S.W. **23**: 345–6
(= *Xysticus rainbowi* Strand, 1901, p. 66; *obscurus* preoc.)

HOLOTYPE: W3521, ♀, Neneba, New Guinea, A. Giulianetti, November 1896. (Poor.)

PYCNOGONIDA

PANTOPODA

Anoplodactylus longicollis Williams, 1941
Mem. Qd Mus. **12**: 36–8
(= *Anoplodactylus longiceps* Stock, 1951, p. 76; *longicollis* preoc.)

HOLOTYPE: W974, ♂, Lindeman Is., Whitsunday Passage, NE. Q., among bushy algae and hydroids, M. Ward. (Spirit specimen with right legs, oviger, and chelophore on six separate slides, all in fair condition.)

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